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AGRICULTURAL ENGINEERING

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Engineering Implications in Agricultural Industries and Services *Paul W. Chapman*

Trends in Hydraulic Power Controls for Farm Machines *Wesley A. Harper*

The Application of Hydraulic Controls to Farm Implements *K. W. Anderson*

Storage Performance of Experimental Grain Bin Floors *Benton M. Stahl*

Effect of Variations in Available Soil Water on Potatoes *John F. Cykler*

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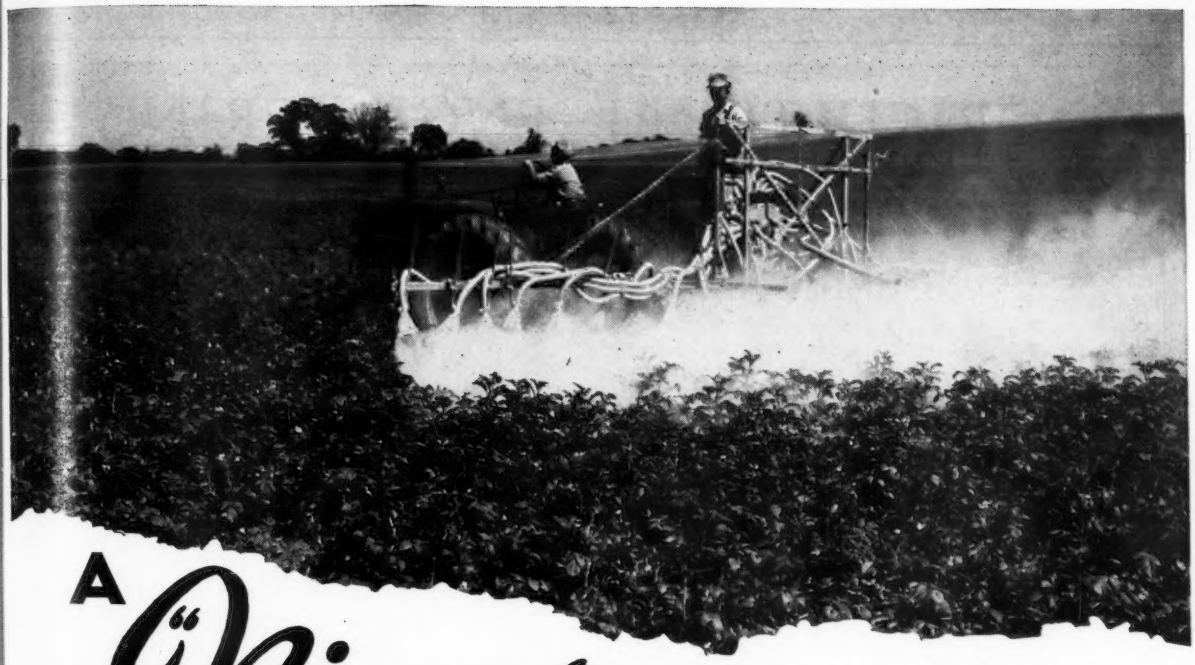

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CONTENTS FOR AUGUST, 1946

Vol. 27, No. 8

EDITORIAL 345

SOME ENGINEERING IMPLICATIONS IN AGRICULTURAL INDUSTRIES AND SERVICES 347
By Paul W. Chapman

TRENDS IN POWER CONTROLS FOR FARM MACHINES 350
By Wesley A. Harper

HYDRAULIC CONTROLS FOR FARM IMPLEMENTS 355
By K. W. Anderson

STORAGE PERFORMANCE OF GRAIN BIN FLOORS 357
By Benton M. Stahl

EFFECT OF VARIATIONS IN AVAILABLE SOIL WATER ON YIELD AND QUALITY OF POTATOES 363
By John F. Cykler

WHY NOT MORE DEEP WELLS AND FEWER PONDS? 366
(Letter - *W. S. Lynes*)

PRESERVATIVE TREATMENTS FOR USE ON WOOD OFF THE GROUND 367
By A. F. Verrall

VITAMIN D POTENCY OF GERMICIDAL RADIATION 369
By Lawrence C. Porter

REPORT OF THE SECRETARY-TREASURER (A.S.A.E.) FOR 1945-46 371

NEWS SECTION 376

PERSONNEL SERVICE BULLETIN 384

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EDITORIAL

Responsibility to Agriculture

TO READERS who did not have the opportunity to hear it, we especially commend Dr. Paul W. Chapman's A.S.A.E. annual meeting address (appearing as the lead article in this issue) as a most inspiring appreciation and challenge to agricultural engineers. Coming from this progressive leader of agriculture and agricultural science, it is especially worthy of detailed study.

In all fairness Dean Chapman asks, Are agricultural engineers prepared to accept responsibility for the engineering needed for the full development of agricultural industries and services? Are the present four major fields of specialization in agricultural engineering adequate to do the job? Have we outlined and developed the scope of agricultural engineering "so that all possible benefits of engineering applications and techniques may be applied to farming and rural life to the same degree that . . . . . engineering serves non-farm vocations and metropolitan centers of population"?

It appears to us that Dean Chapman is on the right track in his implication that the group served, agriculture, as distinguished from all others, is the critical factor in determining the scope of agricultural engineering.

It may clarify the issue to recall some factors which do not define the boundaries of agricultural engineering. A glance at transportation, mining, and hydroelectric power generation and transmission has long since shown us that we have no monopoly on the application of engineering in rural areas. Neither are we primarily concerned with engineering the automobile and other commodities used in common and in much the same ways by farmers and urban people.

Nor can we look forward to any monopoly on the processing of farm-produced organic products. The meat packing and the milling industries have done fairly well with minimum direct employment of agricultural engineers. As long as these and other industries are reasonably well satisfied with the quantity, quality, and cost of their organic raw materials, as available in standard grades from open market sources, they will not be looking particularly for agricultural engineers to handle their engineering problems.

On the other hand, agricultural engineering is not limited as to the geographical location, social or economic organization, or other setup in which it may be exercised, although some obviously provide more opportunity and freedom to operate than others. A lot of good agricultural engineering work has been done in Chicago, Washington, D. C., and other cities, in public service and in industry, as well as on and near to farms.

Most significant, perhaps, is that there is no limit to the range of engineering technology which might be subject to application to agricultural problems, by agricultural engineers.

Actually it appears that much of the engineering technology useful in the development of agricultural industries and services may fall within the mechanical, civil, electrical, and structural groupings already represented in technical divisions of the American Society of Agricultural Engineers. Chemical engineering technology appears likely to become increasingly useful.

In the approach to specific problems in agricultural industries and services, some of the principles involved may be different than those applied to date in the farm power and machinery, farm structures, farm electrification, and soil and water management fields. New techniques and much new application data will be developed. Increased consideration for organic materials and processes, and for the economics and mechanics of profitable enterprise, are implied. Increased emphasis on controls and on specific processes such as refrigeration and dehydration are indicated.

From this it appears that there is no one large and distinct body of engineering technology to be picked up by agricultural engineers and applied to agricultural industries and services. There is room for development of the technologies represented by the four technical divisions of the A.S.A.E., plus chemical technology and possibly others, for application to this class of agricultural problems and opportunities.

To develop our capacity to live up to this broadened concept of agricultural engineering, we need to grasp every opportunity to help farmers and farm communities with their engineering problems in establishing and operating processing plants and marketing facilities; to improve the engineering foundations of farm supply services, farm services, and farm home services.

We need to emphasize this type of work in our meetings. We need to bring in and encourage men who are interested in this type of work, wherever they may be found. We need to add considerably to our fund of application data in our four basic fields of engineering technology. We probably will need to draw from those fields, principles and techniques for which we have previously found little use. We may have to develop a substantial interest in other basic branches of engineering technology.

It seems doubtful that the time is ripe for a new technical division of the A.S.A.E. which would overlap the technologies of the existing divisions; or for a tailor-made curriculum to produce agricultural engineers specialized for careers in agricultural industries and services.

Dean Chapman emphasized the point that "rate of progress is directly proportional to the sum total of background information available." We can begin right now to accept and live up to our full responsibility to agriculture, with only minor changes in our organization and activities, by concentrating effort on increasing the amount and availability to agriculture of background information from any and all branches of engineering technology.

The Perennial Data Book Question

ONE fond dream in the minds of some agricultural engineers persists through the years in spite of the fact that it has failed to materialize. It is the agricultural engineering data book. We find that we editorialized on the subject in 1938, at which time it was undergoing one of its periodic revivals of interest.

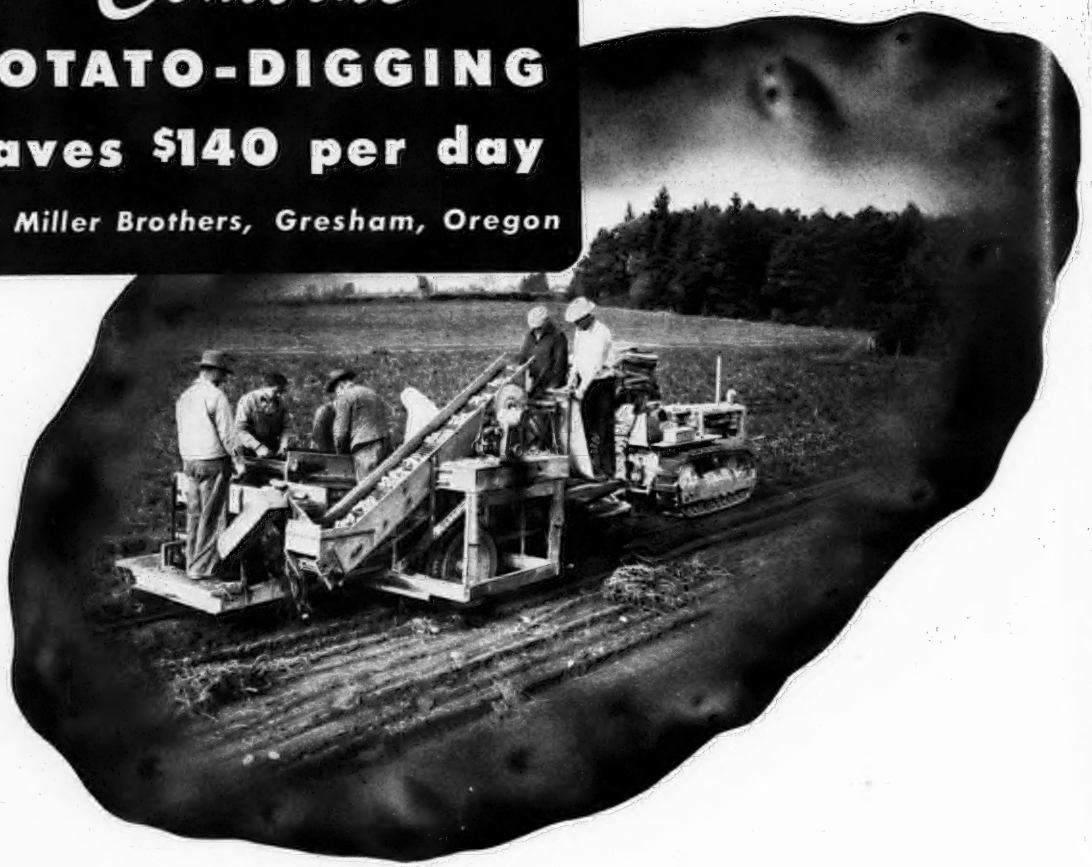
Later, in 1941, a survey of the membership of the American Society of Agricultural Engineers showed only about 4.5 per cent interested and favorable to the project, 0.5 per cent unfavorable, and about 95 per cent indifferent or undecided. Those figures give the apparent reason why the book has not yet materialized. It is only fair to state that the 4.5 per cent interested included many leading agricultural engineers.

Postwar pressures for agricultural engineering progress have created another revival of interest in the project. Possibly there has been a change in the percentage of A.S.A.E. members interested.

In its most basic terms, we believe, the question is one of increasing efficiency in the distribution and use of engineering information. Presum- *(Continued on page 356)*

"Combine" POTATO-DIGGING Saves $140 per day

–for Miller Brothers, Gresham, Oregon



Miller Brothers, Gresham, Oregon, solved the manpower and weather problem (and the high cost as well) of harvesting their large acreage of early market and certified seed potatoes.

They designed and built this potato-digger combine—which adapts the principle of sacking-the-crop-as-harvested, as is done with grain crops in the Pacific Northwest.

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Most remarkable is the money and manpower saving. Operating 7 hours daily, the outfit with a crew of 12, will dig, sack and deliver to storage 1100 full sacks—about 1900 bushels—at a labor cost of only $84.00, or less than 5c per bushel.

Growers commonly pay 10c per bushel for only picking and sacking, plus $35.00 daily for loading and hauling this quantity to storage. So the Millers save about $140.00 per day, throughout potato harvest.

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AGRICULTURAL ENGINEERING

VOL. 27 AUGUST, 1946 NO. 8

Some Engineering Implications in Agricultural Industries and Services

By Paul W. Chapman

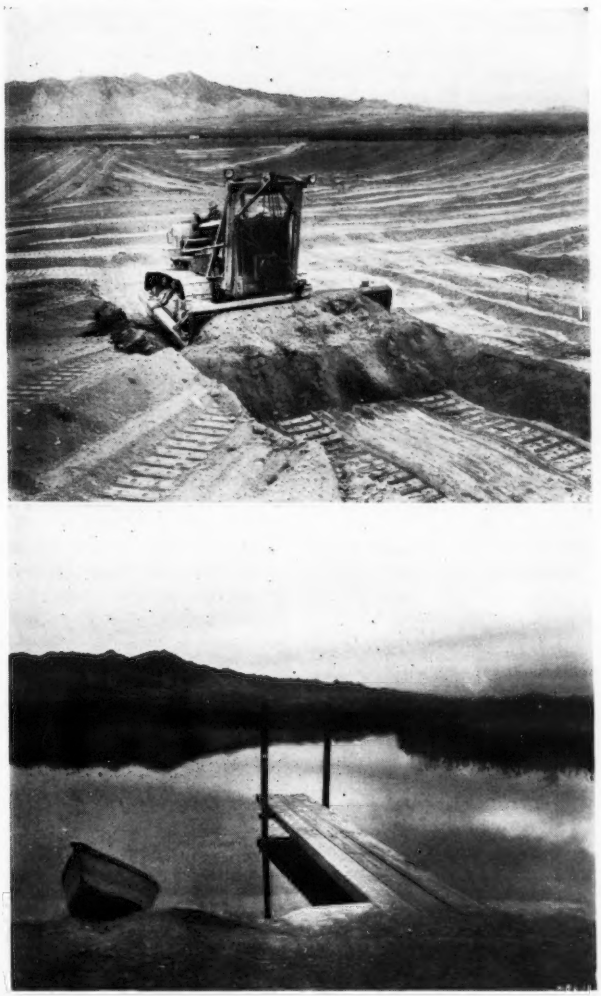
AMERICA owes a very great debt of gratitude to its engineers. No profession has contributed so much in making possible the high standard of living which we now enjoy.

During the first half of the twentieth century now nearing completion, more progress has been made than in any like period of the world's history. A minister, in seeking to convey an understanding of how startling this progress has been, said, "We are farther removed from our grandparents than they were from Moses and the Pharaohs."

Anyone who cares to make a list of those tools, machines, and developments responsible for this progress will discover that all of them represent the work of engineers, or the application of engineering principles. This fact is significant as we look to the future.

Since the rate of progress, at any time, is in direct proportion to the sum total of background information available, we know that changes in the years ahead will take place very rapidly. Also, we know that most of these changes in methods of working and ways of living will come through contributions of members of the engineering profession.

These conclusions apply to the future responsibilities of agricultural engineers. They also are involved in determining the scope of applications that are to be embraced in this branch of the engineering profession.



By the end of 1946, Dr. Chapman says, "There will be no less than 1,000 farm power contractors in the nation engaged in earth moving and related jobs that can be done efficiently only with heavy-duty machinery." In the top view above is shown a Caterpillar Diesel tractor and bulldozer building a 10-acre fish pond on the Kinsley ranch in Arizona; the bottom view shows the finished pond

Agricultural engineering is a very young profession. As yet there are relatively few workers in this profession; they have worked, relatively speaking, but a short time. It is not strange, therefore, that farming and rural life do not enjoy, to the same extent as other industries, the benefits that are to be derived from engineering applications. It is a conservative conclusion to say that these applications must be multiplied if farming is to compete for workers with non-farm occupations, especially with those efficient, highly powered and mechanized industries that more and more tend to set the wage scale for labor in the United States.

During the past month, the American automobile industry, for example, celebrated its fiftieth anniversary. Wages since Henry Ford drove his first car through the streets of Detroit have increased from $1 to $10 or more a day. While it is true that wages may decline from their present high level, it is also true that the trend has been upward for fifty years. In the future, farming must be conducted in such a way that the average farmer can earn at least as much as the typical automobile factory worker — plus a reasonable return on any capital he has invested in his business. This may call for some very drastic changes, as compared with the manner with which farming has normally been conducted in the past.

These changes will include, on an ever-expanding scale, the establishment, ownership, and operation of rural industries, or to use a better and more comprehensive term, "agricultural industries and services."

Upon reading the definition of agricultural engi-

This is an address delivered at the annual meeting of the American Society of Agricultural Engineers at St. Louis, Mo., June, 1946.

PAUL W. CHAPMAN is dean of the college of agriculture, University of Georgia.

neering or the statement of scope, as approved by the American Society of Agricultural Engineers, it is apparent that this branch of the engineering profession is prepared to assume responsibility for *rural processing of farm products* and those engineering applications that will improve *rural living*.

But upon reading the pamphlet issued by your society, entitled "Agricultural Engineering as a Professional Career," it is apparent that only four phases or applications of the profession have thus far been developed sufficiently well to offer fields for emphasis or specialization. These are: Farm Power and Machinery, Farm Structures, Rural Electrification, and Soil and Water Control and Conservation.

Agricultural engineers, as individuals, are now working in several fields of processing, but the Society as a body has not outlined the scope of the responsibilities in this field that it is ready to assume, nor has it instituted on a nation-wide scale training programs that will make possible the preparation of specialists in the field. This may not be desirable, but the needs and possibilities should be explored. Perhaps some official statement should be presented and acted upon, so that those in need of such services will know where to seek them.

Just how far does agricultural engineering want to go in this field? That is the question which must be answered.

On reading the statement explaining agricultural engineering, the following sentence can be framed from the words used: Agricultural engineering is the application of any and all engineering techniques that may be used in the rural processing of farm products. Any one genuinely interested in this field immediately raises the question: Why use the word "rural?"

Does this mean that agricultural engineering will assume responsibility for the engineering aspects of processing only when conducted on the farm or in the rural community? If so, the thought is worth developing so that all persons connected with farming and agricultural services will understand what is meant. On the other hand, there seems to be little practical value in designating the place or conditions under which agricultural engineers will assume responsibility for rendering services incident to the processing of farm products. The word "rural" should probably be omitted from the statement.

FOUR TYPES OF EMPLOYMENT, RELATED TO FARMING, OPEN TO RURAL COMMUNITIES

It is a matter of the most vital importance, however, to realize that the only industrial possibilities open to the typical rural community and small town are those related to farming. If these rural communities are to continue to exist, they must provide employment opportunities — greater opportunities, in terms of the number of jobs, than they have in the past.

There are four types of employment possibilities open to the typical rural community or county seat town that are related to farming, other than retail stores, banks, and commercial establishments. These are: (1) *Processing Plants,* which change the form of farm products, (2) *Farm Supply Plants,* which make the tools and materials which farmers need, (3) *Marketing Facilities,* which provide for assembling, preparing, packing, selling, and transporting farm products, and (4) *Farm and Home Services,* which help make farm work easier or cheaper and home life more comfortable, satisfactory, and appealing.

As a group all these may be classified as *Agricultural Industries and Services.* And as a group, they might well constitute a fifth major, special field in agricultural engineering.

To be specific in regard to the needs of expanding agricultural industries and services, and to convey some vision of possibilities offered, examples from each of the four major divisions into which they fall will be cited:

1 *Procesing Farm Products — Frozen Foods.* Development of the frozen-food industry offers an excellent illustration of the need for local processing facilities. The public has been sold on the idea that frozen foods carry more of the freshness — vitamins and sugars — than foods preserved by other methods. This is not true, if the foods are shipped half way across the continent before being frozen.

Eventually the freezing of foods will be a localized industry closely associated with farm production.

2 *Farm Supplies — Dehydrators.* More and more feeds for livestock and poultry will be dehydrated.

DEHYDRATORS TO BE OWNED BY INDIVIDUAL FARMERS AND BY COMMUNITY COOPERATIVES

Dehydrators will be owned by individual farmers and by community cooperatives. Today hundreds of people are seeking information about the merits of different dehydrators, initial costs, and expenses involved in operation. There are almost no facts available to give the individuals making these inquiries.

3 *Marketing Facilities — New Outlets.* Time was when a farmer's market, in the minds of most people, was an open shed used as a place for assembling, and perhaps packing, farm products.

Today the trend is for markets to provide facilities for simple processing and storage. For example, chickens may be dressed, nuts cracked, fruit polished. Markets may provide curing houses and cold storage.

In the future, markets will also create new outlets for farm products and local resources. For example, in Florida I visited a market that dyed and sold raffia-like strips taken from "cabbage" palms. There are a million dollars worth of this material growing wild in the locality, but not a dime's worth had been sold until the marketing facilities for it were provided.

4 *Farm and Home Service.* One of the marked trends in occupational development in our complex modern economic structure is the multiplication of services. There are today hundreds of services available to city people; in the future, more and more services will be made available to farmers and members of their families.

Earth Moving. All farmers, at times, want dirt moved. They may want roads built over the farm; they may want to construct a fish pond; perhaps there is a building site to be levelled, or terraces to be built; on many farms some land must be cleared of brushes or scattered trees in preparation for the use of power machinery. These are a few of the many dirt-moving jobs on farms, but these are expensive jobs when done with ordinary farm tools. Dirt moving is a special service job. By the end of this year there will be no less than 1,000 *farm power contractors* in the nation engaged in earth moving and related jobs that can be done efficiently only with heavy-duty machinery.

Freezer Lockers. Services to farm homes must be increased. There are a very large number of possible services, but the most important today are those related to the home food supply—community food preservation plants, home freezers, and freezer locker plants.

These developments are so important that they are decentralizing the meat packing industry. Providing efficient locker service involves other related facilities; it includes those required for preparing, processing, and storing foods. For example, it embraces local slaughtering facilities for livestock.

Butane Gas. Farm applications of butane and propane

gas are new. They offer dozens of uses on farms and in farm homes. These expanding gas services are building a new industry, but, as yet, the masses of the people have not discovered their existence.

These are but six examples of agricultural industries and services about which the leadership in agriculture and agricultural engineering should be informed. That the field is very large is evidenced by the fact that I myself have compiled a list of 101 examples; there are probably twice this number.

Agricultural engineering, instead of limiting the scope of its work to "rural processing of farm products" should perhaps assume responsibility for developing the entire field of "agricultural industries and services," with emphasis upon those *small* industries and services which are most needed on farms and in farming communities.

Expanded agricultural industries and services are needed by small towns, the nation, and by farmers.

Any small town that does not provide an increasing number of jobs will decline in population. Rural sociologists say that the typical small town in America is declining in influence, wealth, and population; in many instances, this is apparent to the casual observer.

America has, as yet, not solved its employment problem. At the beginning of World War II, there were eight million unemployed members of the nation's labor force. Soon there will be unemployment again, if we cannot increase the number of jobs supported by the primary producers of wealth — of which farmers are the most important group.

Rural people need more conveniences — more services; farmers, as a group, need higher average, per capita, peacetime earnings. Agricultural industries and services can help provide both.

Few people realize how small a part of the consumer's dollar the farmer has been earning. In the case of cotton, it is 7.5 cents; for tobacco growers, it is 11.5 cents; for fruit and vegetable growers, it is 35 cents.

When all food products are lumped together the division of the consumer's dollar is as follows: Producers, 37 cents; transporters, 7 cents; brokers, 1 cent; processors, 27 cents; wholesalers, 6 cents; retailers, 22 cents.

The only way the farmer can earn more of the dollar is to render more of the services; this applies to the things he buys (supplies), as well as to the commodities he sells. The Doane Agricultural Service, of St. Louis, has long advocated the rendering of these services; it is done in handling the thousands of acres of land which the Service manages. They call this management principle *vertical diversification*. The principle is applied in the thousands of cooperative associations owned and operated by farmers. There is every reason to believe that the principle will be expanded in the future by individual farmers and organized groups.

From the Viewpoint of Agricultural Engineering. An expanded program of agricultural industries and services must be viewed, also, from the standpoint of agricultural engineering.

It is important to realize that the "problem" incident to the development of rural industries and services is usually one involving engineering. To illustrate, as long ago as 1892, it was found by the scientists in one state agricultural experiment station that starch—a very fine starch—could be made from sweet potatoes. Since that time scientists and promoters have been talking about a sweet potato starch industry. They have visualized it as a small, rural industry that might be developed wherever sweet potatoes are grown. The industry has never materialized. Today there is but one plant in operation and that cost 7½ million dollars.

Engineering "know how" is the limiting factor in expanding the program.

Farmers, agricultural workers, and others interested naturally turn to the land-grant colleges, and to departments of agricultural engineering, to provide the information *free of charge,* as all other agricultural information is provided. But, as yet, departments in many states are not prepared to meet the demand. It is an essential service. Agricultural engineers seem to be the logical group to meet the demand. It would seem to present a great opportunity.

Now let us turn, for a moment, to the individual student who might wish to specialize in this field.

At this time it would appear that every experiment station could use one or more workers in this field; every state should have one or more such specialists in its extension service; every college would need a staff. But industry, itself, including farmers' cooperatives, would use a much larger number of such engineers.

The greatest challenge, and opportunity, that should come from a well-planned, efficiently conducted training program in small, rural, agricultural industries and services — both in degree courses and intensive, short-time programs — will be the opportunities that it will open to graduates to go into business for themselves. This is something which, it appears, agricultural engineering may lack at the present time. This possibility, if true, has not yet been realized to any very great degree for the reason that this branch of engineering is very young and has made its greatest growth during a period when educational work and "government jobs" were increasing very rapidly. But with greatly increased college enrollments, placement in a few years may be quite difficult. This is something to which we who are responsible for college training programs must, at all times, give consideration.

But above all else the scope of agricultural engineering must be outlined and developed so that all possible benefits of engineering applications and techniques may be applied to farming and rural life in the future to the same degree that the profession of engineering serves non-farm vocations and metropolitan centers of population.

"Small Machines for Removing Trees and Brush"

TO THE EDITOR:

I WAS interested in the article, entitled "Small Machines for Removing Trees and Brush," by Maurice B. Cox, in AGRICULTURAL ENGINEERING for July, especially since our company is distributor of the Lowther saw shown in Fig. 3 on page 305.

Mr. Cox makes two statements in his paper on which I would like to comment. He says that in cutting large-sized trees with the Lowther saw it becomes more difficult as the diameter increases above 8 in. In the first place, trees 8 in or more in diameter could hardly be classified as brush. While it still may be necessary to remove them in clearing land, these larger-sized trees have a definite value as fuel, pulpwood, or lumber. While it is of course more difficult to take down a large tree than a small one, the increased value of the larger tree more than offsets the extra labor.

As to the saw blade binding when larger trees are cut, I have no hesitation in stating unequivocally that this is due entirely to improper use of the saw. On trees larger than 8 in diameter, the manufacturer's directions clearly call for following normal woods practice, namely that back-cut should first be made from the opposite side of the tree. When the cut is properly made in this manner, the saw will not bind.

I believe, too, Mr. Cox should have perhaps stated more clearly that the difficulty in rapid dulling of the saw blades in cutting at ground level is due to the blade digging into the dirt through carelessness of the operator. Of course, when cutting at ground level, it is extremely difficult for an operator to avoid occasional digs into the ground with the blade.

RICHARD EAMES

Trends in Power Controls for Farm Machines

By Wesley A. Harper
MEMBER A.S.A.E.

THE term "power controls" may refer to any of several different fields of application. Being agricultural engineers, however, we are especially interested in farm machinery and in the application of power controls to it. There are very few fully automatic power applications on the farm. Field operations invariably require one or more attendants. The operator of a machine must frequently steer it and operate its controls.

Power machines are gradually taking over tasks which formerly required the skill of human hands. Power controls are the means of further reducing human energy output.

Backing disk harrows, pulling ropes to lift plows by traction wheels, tugging at long levers to regulate depth or height of operation — these and many other manual operations are being superseded by power controls. Our age of power is rapidly maturing into the age of control of power.

Power controls were pioneered by farmers. They have assembled and installed their own mechanical, air and hydraulic controls. Farm implement manufacturers have adopted power controls to a variety of machines. A host of problems must be solved to adopt power controls to a wide range of mounted and trailing-type implements.

The machine tool industry is a notable example of the use of power controls. Multiple operations are done to shape complicated parts from raw material — all without the aid of human hands.

Large mobile units now use power controls as standard practice. Developments within these fields make a fertile background for the adoption of power controls to farm machines.

Farm machines present their special problems. Some of these problems are lack of available skill for maintenance, space limitations, a variety of implements operated by one tractor, interchangeability of implements and tractors and special operating characteristic requirements. All of these factors emphasize the problems in designing safety into power controls.

Farmers Pioneered Power Controls. Long before large manufacturers offered power-controlled machines to the trade many farmers assembled their own. The usual procedure was to acquire components from available sources and to put them together on the farm, often with the assistance of the local handy man. These installations were usually confined to those tools and areas where heavy lifts were made frequently. These conditions include plowing and cultivating over grassed surface waterways, and irregular areas made by terraces, ditches and checks. These home installations were not highly developed but they did the essential operations for which they were intended.

Large operators have shown a persistent desire for power controls. Their motives are the same as for a manufacturer who employs labor. By making the operation easier and safer, more and better work is obtained, and a greater over-all efficiency results.

During recent years our farms have been operated by older people. Their economic status has been, and continues to be, higher than ever before. Finances have been, and still are, a lesser handicap to the fulfillment of desires than ever before. Farmers are demonstrating their wishes by purchasing power controls as rapidly as they are available. Today's demand is far greater than supply.

Why Farmers Want Power Controls. Power controls of one kind or another have been in use for many years. The question — Why do farmers prefer power controls? — was recently asked of many farmers, farm managers and implement sales people. Answers were somewhat the same, each being colored by the individual's own interest and viewpoint. Perhaps the strongest appeal is to keep the farm workers contented. Once they had used these devices, neither sons nor fathers would be deprived of them.

All agree that power controls make for greater production, higher quality work, greater safety and over-all efficiency. The matter of avoiding getting stuck in soft places and the greater ease of keeping going were always mentioned as advantages.

The fact that major operating adjustments are made from the tractor seat is an important step towards safety. Strains and other injuries often result when getting out of tough spots. The reduction of number of adjusting levers increases safety.

Many older farmers are looking forward to retiring. They want power controls available to the tenant or hired help.

Mechanical Lifts. Several makes of tractors have been offered with power-actuated lifts as attachments. These devices are employed to lift mounted equipment. Speed of lift, as far as the operator is concerned, can be controlled only to the extent that engine speed can be varied, which, under normal conditions, is of little consequence. Speed of lowering is similarly uncontrollable. When the trip is released, the implement either drops to the ground or is lowered at the same speed with which it was lifted.

Another disadvantage of the mechanical lift is its relatively large size. Safety devices in the driving mechanism are not always as reliable as one might wish. In some makes this safety drive is totally lacking. Other disadvantages of mechanical lifts are apparent when advantages of hydraulic controls are considered. Many examples can be cited wherein mechanical lifts are doing a splendid job, they being the best that could be made at the time.

Many types of power controls have been used. Even though the trend is decidedly towards hydraulics, the possibility always exists for other types including air (both vacuum and pressure), electric and combinations of various types.

Features of Hydraulics. Within recent years the art of hydraulics has advanced rapidly. New circuits have been developed. Better materials and improved manufacturing techniques are now available. The fundamental concepts of the behavior of oil under pressure and in motion are being rapidly clarified.

The modern version of a hydraulic control system, particularly for small output systems, is for the supply tank, valve or valves and pump to be in a unit structure, compactly arranged with low weight and small over-all dimensions. The unit, being small, may be mounted at any of several points on the tractor. A mounting for driving from the engine ahead of flywheel clutch has the advantage of power control at all times when the engine is operating.

Hydraulic systems are flexible in that they may include single-acting or double-acting cylinders, or multiples there-

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of, and the cylinders may be operated in any desired sequence. Speed of piston travel may be controlled from very slow to full pump output speed.

Some tractor-operated implements do their best when a single-acting cylinder is used; others require a double-acting cylinder, and so on, throughout the full range of cylinder arrangements. However, for any given implement, or group of implements, the manufacturer may offer only that arrangement which provides the preferred operating characteristics.

In addition to reducing the number of manual operations, the hydraulic control mechanism is useful in attaining the desired operating characteristics of the tractor and implement combination. Some implements do their best work when they are held in a fixed position with reference to the tractor or implement frame. Others should be guided by ground profile independent of the vertical position of the tractor. Implements that are mounted on the tractor, or which have heavy supporting frames, may be best controlled when a selected weight is transferred from the tractor to the implement, or vice versa, yet permitting positioning of the implement with reference to the ground independent of the vertical position of the tractor. This arrangement eliminates the need of ballast weight in the implement; it provides safety when an obstruction is encountered and depth of operation is based upon weight. Hydraulics may also be used to provide safety release, especially for mounted implements, by having the lifting mechanism balanced with desired maximum torque reaction. Further, for mounted implements, the cylinder may be indexed with control lever so that depth of operation may be controlled by a predetermined setting of the control lever. This feature may be had for trailing implements by transmitting piston movement to implement control through a push-pull cable. All hydraulic systems are provided with relief valves which prevent building up pressures above a predetermined level.

Industrial Tractors. The farm machinery industry might well take a look at the industrial tractor business, as the latter is second to the former in volume of business. The latter has employed power controls from the very beginning.

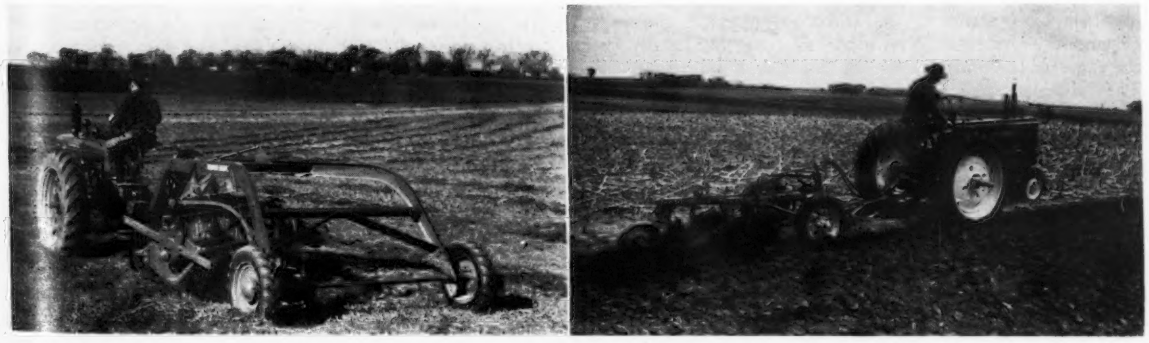
Some models of large track-type tractors are steered by hydraulically powered steering actuators. This application of power controls to ease the operator's burden has an interesting background. Initially the objective was to reduce steering to the lowest level of physical effort. Early in the development process it became apparent that all controls should be balanced, one with the other, to provide uniform "feel" to control levers. The final design which has been in production for several years requires approximately 15 lb of manual effort, this being the preferred amount as determined by operators.

Large wheel-type tractors are equipped with hydraulic boosters which do the actual steering, the manual effort being only for valve operation. This system also keeps steering wheels in the direction of travel regardless of roughness of terrain. Backlash through the steering mechanism, when not so equipped, has caused many wrecks and injuries. Some vehicles are provided with anti-backlash devices without power actuation.

A theory, accepted by many designers, is that power may be transmitted either hydraulically or mechanically. In practice, however, one or the other has dominant advantages. For example, in the actuation of scrapers and bulldozers considerable power must be transmitted through the power controls. Early models were almost exclusively controlled hydraulically. During the past eight or nine years contractors who use large units have become almost unanimous in their preference for cable and clutch actuation. Their criticism of hydraulics, as then available, includes low power output, short life (due largely to high relief valve settings to get more power), and need for greater skill for maintenance and repair. Most cable controls can transmit approximately full engine power, whereas the largest hydraulic systems have been limited to one-third to one-half this amount. In many types of work, production was retarded for lack of power through the control mechanism. In many operations an extra horsepower through the control mechanism is more productive than an equal amount of power through tractive effort.

Great strides are being made in this type of hydraulic system. The successful hydraulic system of today is quite different from that of yesterday. Advancement in the art includes improvements in oil circuits, greater power throughout, less bulk and weight and greater consolidation. Experienced hydraulic manufacturers have learned that precision in metallurgy and in dimensions and finishes are a prime necessity in any hydraulic system. Manufacturing controls from the drawing board, through the shop, inspection and installation call for greater precision in satisfactory hydraulic systems than for most parts of a high output engine, for example.

Direct-Mounted Implements. The modern version of the high-clearance tractor and mounted implements is to contain in the tractor as much, and in the implement as little, as possible. The tractor serves as the main frame for supporting the implement; it powers the implement; it also controls the implement. Implements sold for mounting on one tractor seldom are suitable for use with another. Therefore, the lifting and other control mechanisms employed for mounted implements are of little consequence from the standpoint of interchangeability of implements and tractors. The individual manufacturer has complete freedom in the



(Left) In the Mc-Cormick-Deering heavy-duty, side-delivery rake shown here, the rake cylinder is lifted by hydraulic means • *(Right)* In this picture of a John Deere tractor and plow may be seen the hydraulic power control equipment used

TABLE 1. LIFTING REQUIREMENTS FOR FARM MACHINES

Model	Implement	Size	Drawbar horsepower range of tractor commonly used	Work required to lift implement, in-lb Avg	Work required to lift implement, in-lb Max	Effective maximum piston force required, lb* Lift	Effective maximum piston force required, lb* Drop	Desired lifting time, sec
Regular	Moldboard plow	2-fur	10 - 25	20,000	29,000	5,880	–	1½ - 2
"	"	3-fur	25 - 35	25,000	37,000	7,920	–	1½ - 2
"	"	4-fur	Over 35	35,000	46,000	10,000	–	2 - 2½
"	"	5-fur	Over 35	40,000	55,000	12,000	–	2 - 2½
Deep tillage	Moldboard plow	3-fur	Over 35	35,000	46,000	10,000	–	2 - 2½
		4-fur	Over 35	45,000	58,000	12,000	–	2 - 2½
		5-fur	Over 35	55,000	70,000	14,000	–	2 - 2½
Light	Disk plow	2-fur	10 - 25	16,000	23,000	3,200	–	1½ - 2
"	" "	3-fur	25 - 35	24,000	36,000	4,000	–	1½ - 2
Medium	" "	4-fur	25 - 35	32,000	48,000	5,000	–	1½ - 2
"	" "	5-fur	Over 35	40,000	55,000	6,000	–	2 - 2½
"	" "	6-fur	Over 35	48,000	65,000	7,000	–	2 - 2½
Light	Disk harrow	5 - 10 ft	10 - 25	19,200	19,000	2,400	2,400	1 - 1½
Medium	" "	6 - 8 ft	25 - 35	24,000	24,000	3,600	3,600	1 - 1½
Heavy	" "	6 - 8 ft	Over 35	34,000	34,000	4,300	4,300	1 - 1½
	Combines	5 ft	25 - 35	9,000	12,000	1,500	–	2 - 2½
		6 ft	25 - 35	12,000	14,000	1,750	–	2 - 2½
		12 ft	25 - 35	14,000	24,000	1,800	–	2 - 2½
	Windrower	12 ft	10 - 25	7,500	9,500	1,200	–	2 - 2½
		15 ft	25 - 35	10,000	12,000	1,500	–	2 - 2½
Heavy duty	Mower	9 ft	20 - 35				–	1 -
	Side rake	7 ft	14 - 35	8,000	12,000	2,500	–	1 - 1½
	Grain drill		10 - 25	12,000	18,000	3,200	5,000	1 - 1½
			25 - 35	12,000	18,000	3,200	5,000	1 - 1½
			Over 35	12,000	18,000	3,200	5,000	1 - 1½
	One-way disk plows		10 - 25	22,100	31,900	4,840	–	3 - 4
			25 - 35	25,200	38,500	6,860	–	3 - 4
			Over 35	34,500	65,000	10,100	–	3 - 4
	Corn picker		15-over 35	5,000	5,000	410	–	-
	Listers		10 - 25	20,000	27,500	4,920	–	2 - 3
			25 - 35	34,000	48,700	7,240	–	2 - 3
			Over 35	34,000	48,700	7,240	–	2 - 3

*Maximum piston force required is the effort required to lift or operate implement with bottom of tool in ground and standing still.

Note: The values in this table for hydraulically controlled trailing implements are based upon tests and carefully made estimates. Piston pressures are based on a piston stroke of 8 in. Tests made during the summer of 1946 may cause a slight revision of these values.

design of lifting and other control mechanisms for his mounted implements. However, should some portions of his control mechanism be used for operating trailing implements, he would do well to consider this type of operation before going all out with an individualistic type of design.

The use of hydraulics enables the designer of mounted implements to take full advantage of all of its favorable characteristics. Most of these have been mentioned. Hydraulic cylinders may be arranged at locations best suited for the over-all design. Some hydraulic systems have the cylinder in close proximity to the valve, the piston movement being translated mechanically to the implement control.

About the only criticism of hydraulic systems for mounted implements which has come to the attention of the author is a lack of capacity for some operations. Some installations include springs to assist with heavy loads. By and large, manufacturers are the recipients of continued praise from users who wish more, rather than fewer, of these devices.

There is need for education in general on the fundamentals of hydraulics. Small manufacturers as well as users may not have access to well-informed research and engineering departments. They need to understand fully that the capacity for doing work is a function of pump capacity. They also need to understand that some operations, such as high-lift loaders, must be lifted at a speed related to tractor travel. Remedies for power deficiency are more fundamental than screwing down the relief valve or installing cylinders of various diameters. They need to know that the implement must be designed to operate satisfactorily with available operating pressures and capacities. The matter of good maintenance, such as properly filling with correct oil, freeing of air, cleanliness and non-leaking joints should be dealt with as a broad educational program.

Hydraulic Controls for Trailing Implements. It has been mentioned previously that farmers have promoted the use of hydraulic cylinders on trailing implements. In many instances the components of the hydraulic system have been secured from several sources. Hence the user has had to design the system. Even though he may be qualified to design a safe system with suitable operating characteristics, he may be content with an installation short of his expectations due to lack of available supplies.

The present concept of a hydraulic system for operating a trailing implement involves several components, each properly related to all others, and several operating features which are not obtainable from combinations of components offered by commercial suppliers. Perhaps the best method of illustrating the principles herein suggested is to deal with them separately in an imaginary problem.

Let us assume that we are a farmer and wish to equip a three-base moldboard plow with a hydraulic lifting and lowering mechanism. We are willing to discard unusable portions of the plow and to supply the parts necessary to install the cylinder and connections.

Fortunately we have available certain data (Table 1) based upon tests and carefully made estimates. For lack of research data applicable to the job at hand, we will consider this data as being reliable.

Our data show that the work required to lift the plow, with the tractor standing still, is 25,000 in-lb average and 37,000 in-lb maximum. The amount of work done is of lesser importance to us than the maximum force that the piston exerts at any time during the lifting cycle. When equipped with a cylinder which lifted the plow with an 8-in stroke, the maximum piston pressure was 7,920 lb. In order to get started on the job we will consider that an 8-in stroke is satisfactory. We will endeavor to make the installation so that the plow is lifted when pressure is exerted on the dead end rather than on the rod end of the cylinder. In other words, the cylinder will be extended when the plow is in the raised position, and the cylinder will be collapsed when the plow is in the working position. This will provide a greater piston pressure for the lifting cycle than if the cylinder were installed in the reversed position.

Before finalizing on cylinder installation on the implement, we must arrange for hose connections between tractor and cylinder. The most favorable point for attaching to the cylinder is the front end. Mounting brackets for the cylinder must not interfere with the hose.

Knowing that piston pressure may be proportional to hydraulic pressure, we must therefore rationalize between cylinder diameter and operating hydraulic pressure. Disregarding pressure losses due to line and piston friction, we will use the equation—hydraulic pressure times piston area equals piston force. Selecting several combinations of values for piston area and for hydraulic pressure which will provide piston force of 7,920 lb, we may set down the following:

Piston diameter, in	Piston area, sq in	Hydraulic pressure, psi
3	7.	1131
3¼	8.3	955
3½	9.6	826
3¾	11.	720
4	12.6	628

Not wishing to spend excessively for extra-heavy-duty hose, we shall decide upon a maximum pressure within the limits of hose that are commonly available. We investigate the hose situation and consider the successes and failures of

others and conclude upon a maximum of 900 psi and a cylinder diameter of 3½ in.

Had we installed the cylinder so that the plow was lifted by collapsing the cylinder, a larger diameter would be required to compensate for rod displacement.

Next we consider the period of time in which the plow should be lifted as a prelude to pump capacity determination. Our experience indicates that the plow should be lifted at a speed which will insure uniform depth to the end of the furrow and have all furrows end evenly. It has been determined that satisfactory results are obtained when the lifting cycle is completed in a period of 1½ to 2 sec, and when the tractor travel speed is approximately 3½ mph. Therefore, the pump should have sufficient capacity in volume to fill the cylinder in the prescribed time.

A cylinder of 3½-in diameter and 8-in stroke has a volume of approximately 77 cu in, or ⅓ gal. Therefore, the pump discharge should be at the rate of ⅓ gal per 1½ to 2 sec, or 13.2 to 16 gpm.

Our job is not finished yet. We must have a valve that will provide close adjustments of the cylinder, that is, one that may be partially opened to cause a controlled piston speed. We must be able to set the plow at any predetermined depth within narrow limits. Moreover, we would like an unloading system that will permit the pressure head to fall off automatically at the end of piston travel. Further, we would like to have an arrangement on the cylinder or implement for easily adjusting the limit of piston travel so that the plow will always be lowered to a predetermined depth without worrying about it going too deep. When turning at the end of the furrow, the operator has enough to do without the hydraulic system taking time and attention.

Having designed and constructed this double-acting, single-cylinder system which operates the plow successfully, we next turn to the use of the same tractor with a tandem disk harrow. We desire to install the same cylinder on this implement for controlling the angle of cut.

If we were thorough in our planning, we would have foreseen that the cylinder would detach from the plow and attach to the harrow without disconnecting the cylinder from the tractor. Therefore, the method of attaching the cylinder to the implement and the location of the cylinder rearwards of the tractor drawbar should be the same for both implements.

Next we wish to connect the same cylinder to a power-take-off-driven combine, the hydraulic control being for adjusting height of cut. Here we are apt to run into trouble. Now we find, not two, but five connections between the tractor and trailing implement — drawbar, power take-off shaft, power take-off shield and the two hydraulic hose. Thanks to the standardization of the first three connections, there is no trouble there. We may have to rearrange the hydraulic system (in our example) on the tractor to avoid interference.

As we connect implement after implement to the same tractor, we will endeavor to design the cylinder mounting on each implement so that the standard piston stroke will provide suitable implement actuation. Should some implements require less inch-pounds of work and a corresponding or greater operating time, this may be accomplished by using only a portion of the standard stroke. For example, the mower sickle bar must be dropped quickly and precisely; the bar must clear the freshly cut hay, yet it must be on the ground as it enters the standing crop. We had better secure full sickle-bar control with about one-half to three-fourths of the maximum piston travel.

The full implication of our example is climaxed when we consider the farmer who has done all these things and later wishes to purchase a new tractor or implement. His new tractor may be offered with a complete hydraulic control mechanism as an attachment. His new implement will be designed for cylinder actuation. Will his new tractor hydraulic control mechanism connect onto and operate successfully his home-devised implements? Will his new implements be designed for the cylinder which we have selected?

The adoption of hydraulic controls on an industry-wide basis will be successful only if there exists the necessary standards for complete interchangeability between implements and tractors. These standards for hydraulics are of an importance equal to drawbar and power take-off standards. This program calls for a fundamental approach to the problem and an exchange of engineering information between manufacturers.

Standards for Trailing Implements. Here are the basic items for consideration in a standardization program:

1 Since cylinder size is closely related to other components of the hydraulic system, the cylinder, mounting pins and hose — in addition to a pump, valve and tank which normally mounts on the tractor — might well be considered to be a portion of the tractor. This approach permits freedom of design of detailed features on the part of each tractor manufacturer.

2 Disk harrows, grain drills, land levelers and many other tools require the use of double-acting cylinders. This type of cylinder would be advantageous in securing penetration with moldboard plows, disk plows and disk tillers in hard ground, and on a combine platform in down grain. Variations in dropping or lowering time due to size of cylinder, oil temperature and other features would be

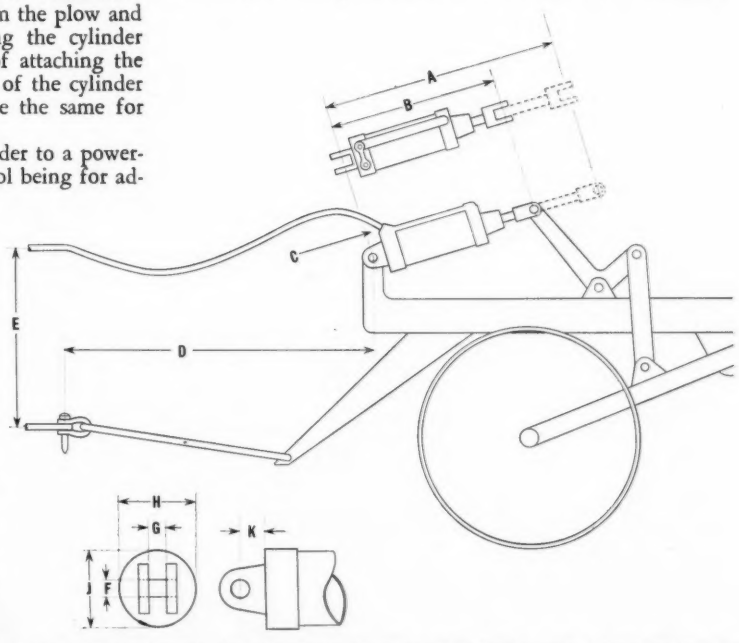


Fig. 1 This schematic drawing shows elements of hydraulic control for a trailing implement attached to a tractor, to illustrate the points that should be subject to standardization

greater and implement control would be less if a single-acting cylinder were used. On certain machines the performance of a single-acting cylinder is required, and this may be had by using the double-acting cylinder with suitable mechanical linkage on the implement.

3 Experience indicates that practically all implements for tractors of 10 to 25 dhp, (drawbar horsepower) or perhaps 35 dhp, can be designed for operation by one length of cylinder stroke. Implements for operation by tractors of greater power may require additional cylinder lengths. Research and field experience will disclose the minimum number of lengths that eventually may have to be furnished. Cylinder length should be expressed as distance between mounting pin center lines with the cylinder collapsed and with the cylinder extended (A and B, Fig. 1).

4 Sufficient space should be allowed on each implement for the largest diameter cylinder that might be used. Due to the fact that all cylinders are not symmetrical around longitudinal axes, this dimension should be shown for the vertical and horizontal directions (H and J).

5 Experience has indicated that a yoke type of connection on the solid or mounting end of the cylinder provides convenience in mounting stabilization of the installation. From a manufacturing point of view it may be considered feasible to provide the cylinder with a similar connection on the rod. The standards should indicate the spacing between the yoke members (G) and clearance between mounting pin and bottom of yoke (K).

6 To secure complete interchangeability a mounting pin size should be selected of sufficient capacity for the larger implements (F). Because of varying farming practices, implements intended for use with smaller tractors may at times be used with larger tractors. The installation would be simplified if mounting pins were supplied with the cylinder. This would avoid duplication of the pins on each implement. The manufacturer would do well to make the process of mounting as simple as possible. This end point would be more easily attained if locking devices for the pins were incorporated in the cylinder rather than in the implements. The designer's attention is directed to the detailed operations involved to install a cylinder. The insertion of the first mounting pin may be difficult due to the weight of the assembly. The second pin can be inserted only when the cylinder has been adjusted to the correct length, and this latter operation must be done hydraulically with the engine operating. If the mounting pin holes must be aligned manually, two men are required for the operation, one on the tractor and the other supporting the end of the cylinder. The latter man is exposed to the danger of the crushing forces of piston movement. It is suggested that designing engineers within the industry might develop a method of mounting, for all to use, that will be free of these shortcomings.

It is desirable that cylinder mounting should be accomplished without the use of hand tools.

7 The length of hose that the tractor manufacturer should furnish to provide complete interchangeability is perhaps the most difficult of all these problems. It is desirable to effect interchangeability without disconnecting hose from cylinder. If any one installation involves the disconnection of hose, the hydraulic system may become contaminated and its life shortened. The inability of the typical user to cope with this situation has already been stressed. The responsibility for standards of hose lengths rests jointly upon the manufacturer of the tractor and of the implement.

The forward hose connection on the tractor varies according to model and make. It is suggested that the tractor manufacturer should supply a length of hose that would pass through a given point vertically above the drawbar of A.S.A.E. position; that this hose would extend rearwards a given distance from that point (D and E). The hose may not actually pass through that point when the tractor is hitched to certain implements. If hose length were standardized in this manner, the manufacturer of the tractor and of the implement will have the problem clearly defined for his purpose.

8 In all designs thus far inspected, the cylinder overall diameter is often greatest at the point where the hose are connected to it. Because of possible interference with mounting brackets, and other parts of the implement, it seems desirable that the point of hose outlet (C) should be included in the standard. Further, the standard might include that the hose outlet should be at the forward end of the cylinder in order to avoid troublesome twists and to make the installation with minimum length of hose.

9 A review of a wide range of implements reveals the fact that practically all of them requiring 35 hp or less should be actuated in a period not to exceed two seconds. The standard might well provide this figure and a lower one, the latter to be determined.

10 Classes should be made for tractors on the basis of power and for the implements operated by them. An additional variation may include track-type tractors which often operate to one side of the center line of draft of plows, for example.

11 During the period of time just ahead, it is foreseeable that many implements will be operated by power controls of greater capacity than the implement designer may have allowed for. This thought is suggested to influence the manufacturer to provide the required strength in the linkage and other parts that might be effected.

12 Several designs, some experimental, have been inspected. There is an apparent divergence of opinion regarding the method of limiting depth or height control. In plows, for example, when traction wheel lifts are used, the depth of penetration is predetermined by means of manual adjustments. Thus, when the operator releases the tripping mechanism, the plow penetrates to the desired depth. Even though the hydraulic control may be easier to operate than the manual control, this principal is still present.

It is apparent, to secure standardization for interchangeability, an adjustable limit to piston travel must be supplied either on the cylinder or on each implement with which it operates. It would seem more economical to provide this adjustment on the cylinder rather than to duplicate it on each of the implements.

CONCLUSIONS

Three economic forces — high cost of labor, favorable prices for farm commodities, and high taxes — impel men to devise mechanisms for extending the frontiers of agriculture. Mechanisms for applying power to the task at hand are the subject of never-ending research and development. An important adjunct in machine development is power controls.

In their present stage of development these power controls have been applied to well-established, as well as to new uses. More uses will be found for them. A few machines now on the market were originally designed with power controls. Others are offered with optional manual or power actuation. Some machines do not lend themselves to this kind of treatment and are, therefore, obsolete.

Dealers are now appraising the value of hydraulically controlled implements in terms of depreciated values for old style trade-ins.

When new machines make old ones obsolete, progress is being made.

Hydraulic Controls for Farm Implements

By K. W. Anderson
MEMBER A.S.A.E.

IN SOME respects the use of hydraulic controls for farm implements can be likened to a good continued story: the subject is most interesting. The development to date represents only one or two chapters. Succeeding chapters will be followed intently, and the end is not in sight.

Those who are prone to scoff at the need for doing things easier will probably seize upon the storybook comparison with considerable zeal, thinking that its importance is being overemphasized. Right here I want to predict that further application of hydraulic controls to farm implements will be regarded as a major improvement. Farmer purchasers will demand broader use of hydraulic controls because of reduction in manual effort. With the right kind of design their use will result in higher daily output, improved quality of work and greater safety. Any increase in equipment costs will be easily offset by advantages which accrue.

There are two general types of farm implements, namely, integral and drawn, and since the application of hydraulic control has been more general on the integral machines, I will discuss this phase of the subject first.

Early recognition of the need for a lifting means for integral implements, other than by manually operated levers, was shown by Emerson-Brantingham who marketed a number of power-operated winch and cable lifts for their integral three-bottom plows. As general-purpose tractors and integral implements came into general use, a number of mechanical gear-type lifts appeared on the market. It will be recalled that John Deere offered a lift of this type in 1928, which was followed by a hydraulic lift in 1934.

To provide intermediate adjustment, in addition to full-cycle lifting and lowering, was the next logical step and this combination is generally referred to as hydraulic control.

In the development of any system of hydraulic control, the engineer's first problem is to determine the maximum force required to lift the heaviest implement to which the control is to apply. From this data, and with a given working pressure available from the hydraulic pump, the size of the cylinder can be easily computed. The next step is to establish the time limit for a complete lifting cycle which in turn establishes the required pump capacity in gallons per minute.

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The oil pumps used with the various hydraulic-control systems are usually either the gear or piston types, each of which has variation. While there are exceptions, most of the piston pumps are used where high pressures of 1500 to 3000 psi are employed. The gear pumps usually have a pressure range of 500 to 1200 psi.

The pump, hose or oil lines and cylinder on high-pressure systems are smaller in proportion to those used in low-pressure systems within a given capacity. Proponents of the low-pressure systems contend that this design is less sensitive to wear, also that minute adjustments in operation position are accomplished more easily. Selection of the type of pump is sometimes dictated by space limitations or available sources of power to drive the mechanism.

Cylinders may be either of the single or double-acting types. Where the single-acting cylinder is employed, downward movement is a function of gravity and/or suction of the implement. This type is almost universally used on integral implements.

The double-acting cylinder is necessary where force must be exerted in both directions. In some instances more effort is required in one direction. Where this condition pertains, a good design dictates that the linkage, from the cylinder to the implement should be constructed so as to take advantage of the greater force which is available on the extending stroke.

There are two general types of hydraulic controls, each of which has variations in design. The selective type produces a full-cycle lift or drop with movement of the control lever to each of the extreme positions. Graduated adjustment is made by minor movements of the lever — the position of the implement being gauged by the eye. International Harvester employ this type of control on their models H and M tractors, which is identified as the Lift-All. It is also used by John Deere on their models A, B and GM tractors, by Allis-Chalmers on their models B and C, by Minneapolis-Moline on their model R, and by Case with their model VAC.

The precision control accomplishes a similar lift and adjustment, except that the position of the operating lever in the quadrant indicates the relative position of the implement. The Ferguson system as applied to the Ford tractor is a modification of precision control. On this tractor the position of the operating lever indicates the relative position of the implement

This picture shows the application of hydraulic power control to a Deere semimounted power mower, powered by a John Deere tractor

except when the draft increases beyond a predetermined limit, at which time the implement is raised. This latter function is automatic and as the draft decreases the implement returns to its normal depth.

The general design of the integral implements, to which hydraulic control is applied, virtually dictates the type of control that can be used. At this point I think it is in order to make a statement to which most engineers agree, i.e., all design represents a certain compromise. It follows that efficiency of the tool as well as cost represents some of the more difficult obstacles.

Let us consider the two-row integral cultivator. One general type has a pair of independent rigs attached to each side of the front end of the tractor and independent rigs back of the rear wheels. A second type consists of a full-length tool bar mounted on the rear of the tractor.

The independent rig cultivators use the selective lift. Harvester's Lift-All has separate external cylinders for each side of the cultivator, and when delayed lift is provided for the rear rigs, a third cylinder is added. Control is operated by a push-and-pull rod with the maximum depth stop being effected with cultivator hand levers. The John Deere control consists of a single internal cylinder with built-in rockshaft that regulates the cultivator as a unit. Maximum depth control is accomplished by means of cultivator hand levers. Other makes of cultivators of this general type use selective control in several variations.

The Ford rear mounted cultivator employs a semi-precision control having an internal cylinder and built-in rockshaft. Leveling of the cultivator is effected by a hand-operated screw incorporated in one of the lifting links connected to the rockshaft. No other cultivator levers are employed.

EVIDENCE OF MUCH PROGRESS IN THE APPLICATION OF HYDRAULIC CONTROL TO INTEGRAL EQUIPMENT

The purpose of this comparison is merely to uncover some of the design problems that confront engineers. I believe that when the various implement manufacturers release information on their latest developments on the application of hydraulic control to integral equipment, it will be evident that much progress has been made.

While considerable progress has been made in the development of integral equipment, of which the plow and the corn picker are good examples, well over half of implements used are of the drawn type. This is particularly true where larger tractors are employed.

For a long time soil-working equipment, such as drawn plows and listers, have been supplied with an efficient wheel-driven lifting mechanism. However, little real improvement has been made in the adjusting means. The regular hand-control levers on plows, listers, combines, corn pickers, potato diggers, field hay choppers, drills, etc., are seldom within convenient reach of the tractor operator. Even when the operator is able to grasp the hand lever, he is often required to exert too much manual effort. In addition, this type of operation does not promote safety.

The need for an improved control has undoubtedly been recognized by many engineers, but since I am not familiar with the efforts of others, I am going to confine my comments to the work being done by the Deere organization.

It soon became evident that rockshaft control, from the tractor to drawn implements by means of cables and pulleys or similar devices, was inadequate. First, it is either necessary or very desirable that the control for the disk harrow, disk tiller, disk plow, grain drill and field cultivator exert force in both directions. In addition, the variation in the tractor-drawbar setting and in the hitch on the implements creates further complications, all of which can be overcome by mounting a remote double-acting hydraulic cylinder on the implement.

The results of a cost analysis of the cylinder and necessary hose lines leads us to believe that the design should facilitate interchangeable use on all implements. The need for a predetermined stop so the implement will return to its previous working level suggests the incorporation of such a device in the body of the cylinder.

A careful study of the operation of the control in the field established a number of other requirements. A complete lifting cycle in two seconds is desirable, yet the graduated adjustment must be at a much slower rate. One way to obtain this kind of performance is with a valve mechanism that produces two-stage operation.

Attachment of the hose lines to the tractor and the cylinder to the implement is sometimes effected several times daily and this necessitates the use of an easy fastening means without wrenches.

Much work remains to be done. Standardization of hose lengths and many other knotty problems will have to be solved. Irrespective of these difficulties, it is certain that hydraulic control of drawn implements is not too far away. With positive hydraulic power to lift and adjust plows, straighten and angle disk harrows, there will be an added incentive to build grass waterways and employ other soil conservation measures.

The Perennial Data Book Question

(Continued from page 345)

ably every engineer is interested in having certain data readily available for reference in connection with his individual work. Some agricultural engineers find their requirements fairly well met by files of existing engineering handbooks, bulletins, periodicals, and reports. Others indicate that searching for and finding, or not finding, the data they need; or assembling, indexing, and filing data from a multitude of sources, so they can find it when they want it, takes a lot of time they would rather be spending on productive work.

An agricultural engineering data book would not provide a complete and final answer to this problem. It could be a big step in the right direction. Whether we like it or not, we have a growing problem in the mechanics of assembling, indexing, filing, and distributing agricultural engineering reference data. The efficiency we achieve in organizing and handling specialized information as a working tool is going to be an important factor in agricultural engineering progress, and in the progress of many individual agricultural engineers.

Compression Distillation for Dehydration

AWAR equipment development of potential agricultural engineering significance is compression distillation as exemplified in the Kleinschmidt unit for distilling seawater as a source of fresh water supply. This patented device obtains high thermal efficiency with a low degree of compression, just sufficient to condense the evaporated vapor in a heat exchanger, thus reusing the latent heat to evaporate additional seawater. Output as high as 175 lb of distilled water per pound of fuel consumed has been reported.

Potential application is evident for concentrating liquid agricultural products, such as skim milk, fruit and vegetable juices, sugar-bearing saps, and solvent extracts. Application to drying of solid materials and complete dehydration of solutions would require modification of the heat exchanger and feed mechanism to suit the material.

A description of the compression distillation equipment and operation appears in "Mechanical Engineering" for March, 1946.

Storage Performance of Grain Bin Floors

By Benton M. Stahl
MEMBER A.S.A.E.

EXPERIMENTAL wheat storage sites were established at Hutchinson, Kan., and Jamestown, N. D., by the Commodity Credit Corporation, USDA, in cooperation with other federal and state agencies to permit various investigations which have been described in AGRICULTURAL ENGINEERING[1]*.

Before this, there had been frequent observations of damaged wheat on the floors of bins used for storage experiments and reports of similar conditions in bins used by farmers and the Commodity Credit Corporation. It was often assumed that these conditions were due to moisture penetrating through or condensing on the floors. Recommendations for the prevention of this damage[2,3] have not been generally adopted, possibly due to a lack of supporting evidence of their desirability or effectiveness. In addition to the need for this evidence, there was a demand for more specific information concerning the relative importance of any defects responsible for such spoilage and for dependable remedies that could be used economically. Therefore, a major purpose of the new experiments was to measure the effectiveness of various types of floor construction and materials in preventing deterioration of stored wheat.

At the Jamestown site, thirteen distinct variations in floor design were installed originally. Each design was used in two plain metal 1,000-bu bins, so that a total of 26 bins were assigned to these studies. At the conclusion of some of the original experiments several modifications were tried. Data on the observed changes in wheat temperature, moisture, and other measures of condition have been assembled from 39 tests that were finally completed. These are presented here as a continuation of a report[4] on similar experiments at Hutchinson.

Performance of Floors in Different Localities. Although the floors installed at Hutchinson and Jamestown were almost identical, there were notable differences between the two bin sites. At Jamestown, there was excellent surface and soil drainage and the site was never flooded. At Hutchinson, opposite conditions existed. The amounts of precipitation at each site are given in Table 1. Drifting snow (Fig. 1) was a more serious hazard at Jamestown than these records would indicate. But it should be noted that, whenever snow accumulated against the bins having experimental floors, it was shoveled or swept away before melting could occur.

With these relatively favorable conditions at Jamestown, and using the same measures of floor performance, much better results might be expected than were reported from the Hutchinson tests. However, the total amount of visibly spoiled wheat found in the 39 tests reported in Table 2 is only 30 bu less than the estimated amounts in the 44 Hutchinson tests. In the bins at Jamestown, the amount of visible damage that could be traced to water leakage through defective roof, door, or wall joints *above the floor* was never large enough to require separate classification. Floor performance as measured by the final moisture content of the wheat on the center of each floor shows approximately the same results for similar floor installations at both localities.

These results indicate that the construction features and materials used in the floors of exposed bins are as important as the climate and bin-site conditions. Further evidence of this is shown by the absence of visible damage in many bins and the presence of excessive amounts of spoilage in other bins at each storage site.

At both localities seasonal fluctuations in the moisture content of the bottom 15 in of wheat were found. The results from the Jamestown tests are given in Table 2. At Hutchinson these periodic tests were discontinued after January, 1943. The averages for each of the first three samplings of the Hutchinson bins in the 2-year group are: January, 11.19 per cent; July, 11.44 per cent, and January, 11.21 per cent; and in the 3-year group: January, 11.20 per cent; July, 11.56 per cent, and January, 11.28 per cent.

The above condition is of interest because it would influence the development of various types of deterioration. Available data on deterioration cannot be included in this report. But they show that in the absence of roof or wall leaks, no abnormal deterioration occurs

TABLE 1. PRECIPITATION, IN INCHES, AT EXPERIMENTAL STORAGE SITES DURING TEST PERIODS

	1941		1942		1943		1944		53-yr. average	
	Hutchinson	Jamestown	Hutchinson	Jamestown	Hutchinson	Jamestown	Hutchinson	Jamestown	Hutchinson	Jamestown
Jan	.....	.....	0.35	trace	0.20	0.37	0.65	0.20	0.67	0.55
Feb	.....	.....	1.29	0.04	1.03	1.38	1.43	0.23	1.10	0.59
Mar	.....	.....	1.65	1.62	0.81	2.43	3.49	0.87	1.58	0.90
Apr	.....	.....	6.63	3.70	1.27*	1.14*	9.72	0.44*	2.69	1.70
May	.....	.....	1.21	4.57	3.42	1.88	5.43*	3.00	4.09	2.77
June	9.44*	4.80	10.78	2.92	3.42	4.77	.....	.....	4.05	3.50
Jul	3.64	2.28	2.90	1.61	4.30	2.31	.....	.....	3.02	2.70
Aug	3.19	2.70*	4.90	5.24	3.40	3.06	.....	.....	3.13	2.55
Sep	3.86	3.20	8.39	2.52	2.59	0.23	.....	.....	2.96	1.67
Oct	6.41	1.86	5.58	0.75	3.37	0.57	.....	.....	2.06	1.29
Nov	0.82	0.30	0.77	0.24	0.15	0.43	.....	.....	1.59	0.67
Dec	1.01	0.03	2.30	0.32	2.60	0.13	.....	.....	0.89	0.66
Total	38.96	19.91	46.75	23.53	26.56	18.70	.....	.....	27.83	19.54

*Months when bins were filled or emptied.

Fig. 1 A typical condition of drifting snow at the Jamestown, N. D., experimental wheat storage site

This paper was prepared expressly for AGRICULTURAL ENGINEERING.

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*Superscript numbers refer to appended references.

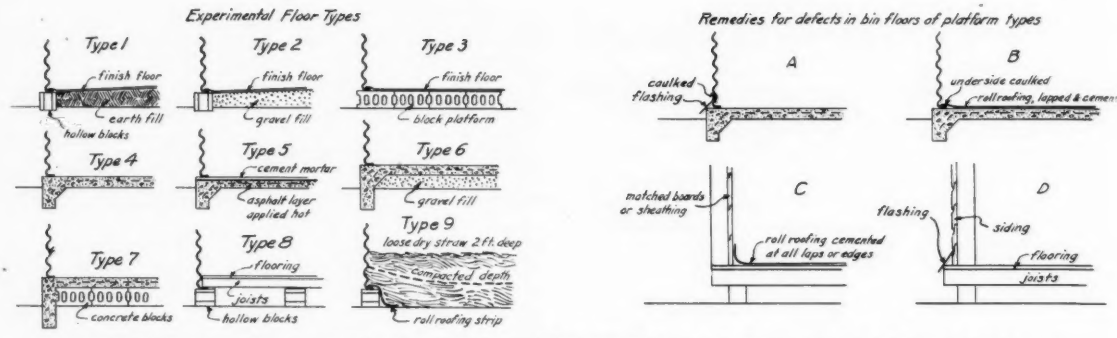

Fig. 2 Diagrams of experimental and commonly used floor installations and of remedies for defective installations

in wheat on floors that prevent the entrance of leakage water or the penetration of moisture from the subfloor.

Floor Construction and Materials. Diagrams of the several types of floor installations are given in Fig. 2. The floor materials in contact with the wheat and the protective features in each installation are listed in Table 3 for comparison with the results given in Table 2. It is evident that caulking at the floor-wall joint was ineffective (Figs. 3 and 4) in some types of floor installations. In other types, tests 13 and 34, excellent results were secured without any caulking at this joint. Such conflicting evidence does not indicate that caulking is useless. But it does show that caulking has definite limitations as a remedy for poor design and that it may not be needed in other designs. Thus it should be noted that in tests 13 and 34 water could not accumulate at this junction because it would drain through the openings in the concrete blocks. Also, as previously mentioned, snow was removed before it could melt. If these favorable conditions had not existed, the test results might have been quite different.

Installations in which the walls shielded both the subfloor and finish floor proved effective in preventing the development of excessive amounts of visibly damaged wheat. Other types of installation which were not thus shielded by the walls failed to prevent this kind of damage. Flashing the floor-wall joint proved to be a satisfactory remedy for this defect in design — a defect which is always present when the finish floor is used as a platform to support the bin walls.

Wood or concrete floors are most frequently misused as platforms. It will be noted that in these tests every concrete finish floor was of a platform type. And while these experimental floors were under test, twelve other bins (not included in the floor tests) having wood or wallboard

TABLE 2. MOISTURE CONTENT OF WHEAT ABOVE, AND AMOUNTS OF SPOILED WHEAT ON, BIN FLOORS

Test no.	Moisture content of wheat, per cent: Initial average of bin* per cent	Avg. of bottom 15 in from special sampling locations† 1942 Jan	1942 Jul	1943 Jan	1943 Jul	1944 Jan	Final bottom 2 in at center	Inspection of wheat on floors: Evidence of leaks at (a) or near (n) sampling location North	Center	South	Visibly damaged wheat (moldy, caked or rotted), lb
STORAGE PERIOD — 20 MONTHS											
1	12.7	13.6	13.7	13.2	.....	.....	16.4‡	a	a	a	1,716
2	12.5	12.7	13.1	12.0	.....	.....	14.6	a	n	a	1,202
3	11.8	11.7	12.5	11.7	.....	.....	15.7	a	n	a	815
4	11.8	11.8	12.6	11.9	.....	.....	13.7	a	–	a	475
5	11.4	12.0	12.5	11.7	.....	.....	14.0	n	–	–	200
6	12.4	12.9	13.4	12.6	.....	.....	13.3	n	–	–	94
7	12.6	12.4	12.8	12.0	.....	.....	15.7	n	n	a	73
8	12.1	12.0	13.0	12.1	.....	.....	12.1	n	–	–	36
9	11.9	11.7	12.9	12.0	.....	.....	12.0	a	–	–	21
10	11.6	11.8	12.8	11.7	.....	.....	11.8	n	–	n	16
11	11.3	12.1	12.9	11.7	.....	.....	13.2	–	–	–§	3
12	11.6	11.6	12.7	11.9	.....	.....	12.9	n	–	–	3
13	13.0	12.3	13.0	12.3	.....	.....	12.7	n	–	–	1
Avg.	12.05	12.20	12.92	12.06							
STORAGE PERIOD — 12 MONTHS											
14	12.6	.....	.....	.....	12.6	12.6	14.7	n	–	–	84
15	13.2	.....	.....	.....	13.2	12.6	16.6	n	–	–	30
16	11.7	.....	.....	.....	12.0	11.7	12.8	n	–	n	25
17	11.8	.....	.....	.....	12.2	11.8	13.0	a	–	–	18
18	11.9	.....	.....	.....	12.1	11.6	13.8	n	–	–	13
19	12.7	.....	.....	.....	12.7	12.1	13.3	n	–	–	7
20	12.6	.....	.....	.....	12.9	12.8	12.9	a	–	–	3
21	11.6	.....	.....	.....	12.0	11.7	11.9	n	–	–	2
22	11.7	.....	.....	.....	11.9	11.4	12.0	–	–	–	2
23	12.0	.....	.....	.....	12.3	11.9	12.2	–	–	–	0
24	11.7	.....	.....	.....	11.7	11.3	14.2	–	–	–	0
25	11.6	.....	.....	.....	12.0	11.6	11.9	–	–	–	0
26	12.7	.....	.....	.....	12.8	12.0	13.5	–	–	–	0
Avg.	12.14	.....	.....	.....	12.34	11.93					
STORAGE PERIOD — 32 MONTHS											
27	12.5	13.0	13.7	13.2	13.3	12.9	18.4‡	a	a	n	1,258
28	12.7	13.0	13.9	13.3	13.1	12.9	28.0	a	a	a	1,069
29	12.6	13.2	13.7	13.3	13.0	13.0	17.2	a	n	a	728
30	12.4	12.9	13.5	12.5	13.4	13.0	17.1	a	a	a	546
31	12.3	12.6	13.1	12,3	13.0	12.8	14.0	a	–	a	287
32	12.8	12.9	13.4	13.0	13.2	12.7	13.0	a	–	n	69
33	13.2	13.3	13.7	13.1	13.3	12.7	13.0	n	n	–	69
34	13.2	13.0	13.4	12.8	12.9	12.3	12.7	n	–	n	51
35	11.7	11.1	12.4	11.1	11.7	11.9	13.4	n	–	–	42
36	12.9	12.6	13.1	12.5	12.8	12.0	12.1	n	–	–	20
37	13.4	12.9	13.5	12.7	13.2	12.6	12.9	n	–	–	14
38	12.8	12.7	13.7	12.9	13.3	12.8	13.2	–	–	–	1
39	13.5	13.7	14.0	13.3	13.4	13.4	13.2	–	–	–	1
Avg.	12.77	12.84	13.47	12.77	13.05	12.70					

* Each bulk of wheat in these tests graded No. 3 (or better) Dark Northern Spring.

† These locations are 1 ft from the north wall; 1 ft from the south wall, and at the center of the floor.

‡ Wheat does not include caked and rotted portion.

§ No leaks were observed at or near the sampling locations. The small amount of caked wheat was found under a leaky bolt in the anchor iron on the northeast wall.

TABLE 3. FLOOR MATERIALS AND CONSTRUCTION FEATURES

Test no.	Floor type*	Materials used for finish floor	Materials used for subfloor	Barriers to penetration of water vapor or capillary moisture	Protection from wall drainage† Shielding at edges of finish floor	Protection from wall drainage† Shielding at edges of subfloor	Protection from wall drainage† Caulking at floor-wall joint	Amount of spoilage, lb (Table 2)
				TESTS IN 20-MONTH STORAGE PERIOD				
1	4	concrete	earth	.....	.....	.....	outside	1,716
2	4	paperboard	concrete on earth	underside paperboard alum. painted	walls‡	.....	do	1,202
3	6	concrete	gravel	gravel subfloor	.....	.....	do	815
4	7	concrete	hollow blocks	hollow block subfloor	.....	.....	do	475
5	5	cement mortar	concrete on earth	asphalt over subfloor	.....	.....	do	200
6	8	metal	wood joists only	metal finish	walls	walls	inside	94
7	4	loose boards	concrete on earth	.....	do	.....	outside	73
8	3	metal	hollow blocks	metal finish floor	do	.....	inside	36
9	2	metal	gravel	metal finish floor	do	hollow blocks§	do	21
10	8	loose boards	wood floor	paper and asphalt over subfloor**	do	walls	do	16
11	4	loose boards	concrete on earth	paper and asphalt over subfloor	do††	.....	outside	3
12	8	matched boards	wood joists only	free air space in subfloor	do	walls	inside	3
13	1	metal	earth	metal finish floor	do	hollow blocks	.....	1
				TESTS IN 12-MONTH STORAGE PERIOD				
14	4	concrete	earth	.....	flashing	.....	outside	84
15	4	emuls. asphalt	concrete on earth	emulsified asphalt over subfloor	do	flashing	do	30
16	5	cement mortar	concrete on earth	asphalt over subfloor	do	do	do	25
17	7	concrete	hollow blocks	hollow block subfloor	do	.....	do	18
18	4	concrete	earth	.....	do	.....	do	13
19	4	silo paper	concrete on earth	silo paper finish floor	do	flashing	inside	7
20	8	metal	wood joists only	metal finish floor	walls	walls	do	3
21	3	metal	hollow blocks	metal finish floor	walls	.....	do	2
22	4	loose boards	concrete on earth	paper and asphalt over subfloor	flashing	flashing	outside	2
23	1	roll roofing	earth	55-lb roll roofing finish floor	walls	hollow blocks	inside	0
24	4	loose boards	concrete on earth	.....	flashing	flashing	outside	0
25	8	loose boards	wood floor	paper and asphalt over subfloor	walls	walls	inside	0
26	9	straw	earth	.....	lined‡‡	.....	.....	0
				TESTS IN 32-MONTH STORAGE PERIOD				
27	6	concrete	gravel	gravel subfloor	none§§	.....	outside	1,258
28	4	concrete	earth	.....	do	.....	do	1,069
29	7	concrete	hollow blocks	hollow block subfloor	do	.....	do	728
30	4	paperboard	concrete on earth	underside paperboard alum. painted	walls	none§§	do	546
31	5	cement mortar	concrete on earth	asphalt over subfloor	none§§	none§§	do	287
32	2	metal	gravel	metal finish floor	walls	hollow blocks	inside	69
33	8	metal	wood joists only	metal finish floor	do	walls	do	69
34	1	metal	earth	metal finish floor	do	hollow blocks	.....	51
35	4	loose boards	concrete on earth	.....	do	none§§	outside	42
36	3	metal	hollow blocks	metal finish floor	do	none§§	inside	20
37	8	loose boards	wood floor	paper and asphalt over subfloor	do	walls	do	14
38	8	matched boards	wood joists only	free air space in subfloor	do	do	do	1
39	4	loose boards	concrete on earth	paper and asphalt over subfloor	do††	none§§	outside	1

* Numbers refer to floor types shown in diagrams.

† Good surface and soil drainage was provided for all bins. Any snow drifting against walls was removed before melting could occur.

‡ This indicates that bin walls extend over and under the finish floor material if they do not extend over and under the subfloor.

§ Water from walls drains through hollow blocks at edge of subfloor and cannot accumulate on subfloor surface.

** Two sheets of kraft paper sisal reinforced and cemented together with layer of asphalt.

†† Bin walls extend over and under the finish floor and paper.

‡‡ See diagram showing strip of roll roofing to protect straw from wall drainage.

§§ No shielding of finish or subfloor was provided during first 20 months of storage. Flashing was then installed without empting bin.

floors used as unshielded platforms were filled for observations of strength and general performance. When these bins were emptied visibly damaged wheat was found, without exception, at the junction of the walls on the platforms.

Some platform types of concrete floors were provided with commonly used moisture barriers to permit a demonstration of their effectiveness. But grain in contact with a bin floor, especially of a platform type, can receive moisture from sources other than wet soil. And the frequent failure of caulking as a means for protecting these floors from wall drainage often caused so much visible spoilage that the results cannot be used for final conclusions concerning moisture barriers. However, when moisture barriers were used, there were indications of benefit, as shown in Table 4.

With one exception (aluminum painted paperboard), less favorable results were secured with moisture barriers that were effective only in checking the movement of capillary moisture (Fig. 5) than with those that were also vapor barriers. It should be noted that the unpainted edges of the corrugated paperboard used in tests 2 and 30 absorbed water from the concrete platform. The condition that resulted is shown in Fig. 6.

It is also interesting to note the limited amount of visibly spoiled wheat on the board finish floor shown in Fig. 7. While boards do not constitute an effective moisture barrier, they do prevent the wheat from coming into immediate contact with water on the concrete floor, and they can also absorb some water that may drain onto the concrete platform.

Floor Materials Not in Common Use. Some of the tests (tests 2, 15, 19, 23, 26 and 30) involved floor materials that have not been commonly used in grain bins. Three of these (straw, roll roofing, and silo paper) proved satisfactory in maintaining the quality of the wheat. The straw fill (type 9 in Fig. 2) was compacted to half its original depth of two feet. Approximately 10 bu of wheat had sifted through the straw, most of which could be shaken out as the straw was removed. None of this wheat was visibly damaged. The straw was also found in good condition except for the bottom three inches, which felt damp and had many moldy areas. Another test is in progress using a

reinforced kraft paper cover over a straw fill. This may facilitate the recovery of wheat and make this type of floor more suitable for emergency or temporary storage in the field.

Emulsified asphalt on a concrete floor proved to be ineffective in preventing excessive dampness and deterioration in the wheat on the floor. This was not due to water leakage. The wheat in contact with the asphalt coating was not visibly damaged but had a musty odor. In contrast to this was the normal odor of the wheat on leak-free portions of identical but uncoated concrete floors in tests 14 and 18. There is no reason to assume that a coating of emulsified asphalt would produce a musty odor. But if the concrete floor had previously acquired such an odor, the asphalt covering might not prevent the penetration of that odor.

TABLE 4. VISIBLE SPOILAGE ON FLOORS OF PLATFORM TYPES NOT SHIELDED FROM WALL DRAINAGE

Test numbers	Floor materials and construction features	Average amount of spoilage, lb	Description of visibly damaged wheat
1 and 28	concrete on earth, no moisture barrier*	1,392	uniform layer over entire floor
3 and 27	concrete on gravel*	1,036	uniform layer but drier near center of floor
2 and 30	concrete on earth, aluminum painted paperboard†	874	mostly within 2 ft of entire floor-wall joint
4 and 29	concrete on hollow blocks*	602	within 1 ft of entire floor-wall joint
5 and 31	concrete on earth, asphalt membrane*	244	within 1 ft of most of floor-wall joint
7 and 35	concrete on earth, loose boards†	58	restricted areas extending from wall along edges of boards
11 and 39	concrete on earth, loose boards on layer of paper and asphalt†	2	spots near walls

* No shielding from wall drainage.
† Partial shielding from wall drainage.

In a previous test (test 1) this concrete floor had become entirely covered with moldy or rotted wheat. After this wheat was completely removed, the floor was permitted to "dry" for five days before applying the first coat of asphalt. During this period the weather was cool and damp, and the concrete surface felt damp even though it appeared to be dry. A similar period of "drying" under these weather conditions preceded the application of a second coat of asphalt. Five days after this the asphalt had not lost its tacky condition and the material had a tendency to stick to one's shoes and peel away from the concrete. However, the bin was filled because further delay seemed useless.

Because of these conditions, definite conclusions as to the merit of this material are not justified. But evidently it does have limitations which should restrict its use to thoroughly dry and odorless concrete.

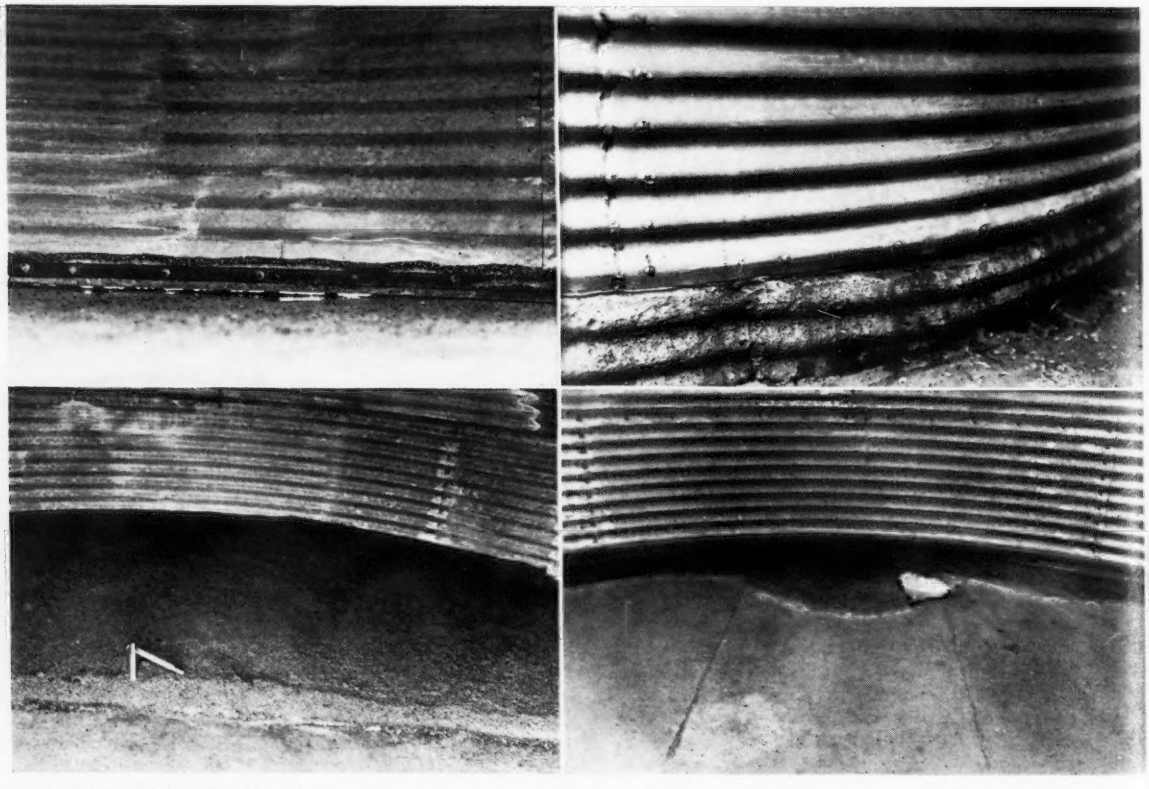

Fig. 3 (Upper left) Floor of bin in test 3, after removing caked wheat along floor-wall joint of east wall. Caulking had separated from the concrete permitting water to enter (visible here after pouring water on outside of wall) • Fig. 4 (Upper right) Exterior view of portion of east wall of bin seen in Fig. 3. The separation of caulking from concrete finish floor could not be detected by visual inspection before the bin was emptied. Stains on concrete are from water poured on bin wall. • Fig. 5 (Lower left) Floor of bin used in test 27. Use of gravel fill to stop capillary movement of water has not prevented extensive spoilage, due partly to water leakage through floor-wall joint during first 20 months of storage • Fig. 6 (Lower right) Floor of bin in test 2 after removing caked wheat. Corrugated paperboard near walls was almost completely disintegrated; however, the aluminum painted bottom surface remained bright and intact as shown by folded back portion

TABLE 5. SEASONAL CHANGES IN WHEAT MOISTURE CONTENT AT LOCATIONS SHOWING *NO* EVIDENCE OF WATER LEAKAGE

Location of wheat above floor, in	Average change in moisture content, in per cent, between successive sampling dates: Increase during Jan 1942 to Jul 1942, floors over fill	air	Decrease during Jul 1942 to Jan 1943, floors over fill	air	Increase during Jan 1943 to Jul 1943, floors over fill	air	Decrease during Jul 1943 to Jan 1944, floors over fill	air	Average net change in moisture content, in per cent, between successive sampling dates Jan 1942 to Jan 1944, floors over fill	air	All floors
ONE FOOT FROM NORTH WALL											
10 to 15	0.71(3)*	1.40(1)	0.98(3)	0.75(1)	0.81(1)	0.57(1)	0.50(2)	0.55(1)	−0.11(9)	+0.17(4)	−0.02(13)
5 to 10	0.68(3)	1.36(1)	1.07(3)	0.98(1)	1.19(1)	0.66(1)	0.55(2)	0.67(1)	−0.12(9)	+0.09(4)	−0.05(13)
0 to 5	0.77(3)	1.03(1)	1.12(3)	0.75(1)	1.39(1)	0.19(1)	0.21(2)	0.56(1)	−0.01(9)	−0.02(4)	−0.01(13)
CENTER OF FLOOR											
10 to 15	0.51(9)	0.64(8)	0.79(9)	0.79(8)	0.53(5)	0.49(3)	0.38(9)	0.28(7)	−0.10(32)	−0.06(26)	−0.08(58)
5 to 10	0.52(9)	0.67(8)	0.72(9)	0.74(8)	0.53(5)	0.49(3)	0.31(9)	0.30(7)	−0.06(32)	−0.04(26)	−0.05(58)
0 to 5	0.43(9)	0.78(8)	0.66(9)	0.73(8)	0.37(5)	0.36(3)	0.10(9)	0.24(7)	+0.02(32)	−0.01(26)	+0.01(58)
ONE FOOT FROM SOUTH WALL											
10 to 15	0.93(5)	0.63(6)	1.01(5)	0.70(6)	0.47(2)	0.30(3)	0.72(6)	0.68(7)	−0.21(18)	−0.19(22)	−0.20(40)
5 to 10	0.74(5)	0.83(6)	0.87(5)	0.69(6)	0.38(2)	0.20(3)	0.63(6)	0.63(7)	−0.20(18)	−0.14(22)	−0.17(40)
0 to 5	0.60(5)	0.59(6)	0.77(5)	0.64(6)	0.42(2)	0.23(3)	0.10(6)	0.56(7)	−0.04(18)	−0.16(22)	−0.10(40)

* Number of tests shown in parentheses.

The tests on aluminum paint as a vapor barrier were inconclusive because of deterioration of the paperboard to which the paint was applied (Fig. 6).

Remedies for Defective Floors. Many farm storages have been erected on concrete or wood platforms which extend beyond the bin walls. Spoilage has always been observed in wheat stored on such floors. Some of the tests demonstrate that this can develop into a serious loss. Elaborate alterations are not required to remedy the defect in this type of floor. A strip of metal flashing attached to the bin walls by metal screws at the position shown in diagram A of Fig. 2 proved effective. This method of protecting the floor was adopted, even though somewhat difficult to install on a round bin, because it did not interfere with the tests on various floor treatments and coverings. Otherwise the more effective and simple remedy illustrated as diagram B would have been used on the concrete platforms.

If considerable shoveling is necessary, as in a bin used for feed storage, the roll roofing can be covered with boards or a cement topping. A similar application of roll roofing (diagram C) is suitable for bins having wood platform floors where external studding prevents the effective use of flashing. Since the wall sheathing does not provide a lip (such as that in metal walls) to support the edges of the roll roofing, the latter should extend upward a few inches on the wall as shown. For rectangular bins having internal studding, the application of flashing (diagram D) is probably the simplest protection that can be used effectively.

Temperature and Moisture Variations. The importance of temperature gradients in directing the movement of water vapor from one portion to another in a bulk of wheat has been indicated by Canadian investigators[5]. They point out "that no uniform moisture gradient is built up between cold and hot portions but instead discrete areas of high and low moisture are established in the wheat, presumably through transfer of moisture by convection currents created in the interkernel air." Other investigators[6,7] who have analyzed the composition of interkernel air at different depths in stored bulks provide further evidence that convection currents exist. These references to convection currents that may be induced by temperature differentials call attention to a factor that has not been measured in numerous experiments which show that moisture accumulates near the cold side of walls having fill-type insulation[8]. Extensive publication of these facts has probably encouraged a rather common belief that a similar condition, *i.e.*, moisture accumulation, will develop in wheat contacting bin walls and floors that are cold.

Fig. 7 Floor of bin in test 7 showing caked portion apparently due to water seeping through defective caulking and accumulating between concrete base and board finish floor

But these investigations under controlled laboratory conditions have been limited to studies of the cumulative effects of constant temperature differentials. In completely exposed "outdoor" bins, such as those used in the floor tests, the wheat temperatures are continually varying. The only constant condition is one of change. Examination of the temperature gradients in Figs. 8, 9, and 10 shows that the bottom foot of wheat generally has a temperature different from that at the exposed walls and in the center of the bulk. During the four-month period April through July, the wheat at the walls is warmer than the bottom foot of wheat and that in the center of the bulk about 2½ ft above the floor is cooler. This relationship becomes reversed in September, the walls being cooler and the center being warmer than the bottom layer, and continues thus for five months through January.

This would indicate that the bottom foot of wheat lies in the path of a convection movement of air during nine months of the year. From April through July cool air from the bulk center presumably moves down to the floor replacing air removed from the floor by upward convection along the warm walls, and from September through January cool air from the walls moves down to the floor replacing air convected up through the comparatively warm bulk center.

The water vapor convected by the air from the bulk center or the walls would influence the moisture content of wheat which it contacts. In unpublished reports and data on moisture changes in these portions of stored bulks it has been shown that wheat very close to the walls, particularly to the south wall, becomes much drier during storage, and that the wheat near the center of the bulk tends to increase in moisture content. It has also been shown that the relative

humidity of the interkernel air at these locations is determined by the moisture content and temperature of the surrounding wheat.

Under these conditions, an increase in the moisture content of the wheat near the floor would be expected if tested in July and a decrease in this moisture if tested in January. The data on seasonal changes in moisture content which have been summarized in Table 5 indicate that these moisture changes actually occur. Furthermore, if these data are compared with the net change at corresponding locations for all floors, it is found that the periodic variations are not due to chance. The chi-square test gives values that are highly significant for these variations at each sample location. But the same test shows that the small average and net differences in moisture content between wheat on floors over fill and over air are non-significant. The monthly rates of change during successive periods of increase and decrease in moisture content cannot be determined from the available data without the use of unjustifiable assumptions. Further tests will be needed for this purpose.

When discussing the performance of floors at different localities, it was noted that abnormal deterioration did not develop in wheat on good floor installations when there was no leakage water from other parts of the bin. The periodic reduction in moisture content of wheat would certainly tend to retard the progress of deterioration that would develop if the increase in moisture observed from January to July continued throughout the year.

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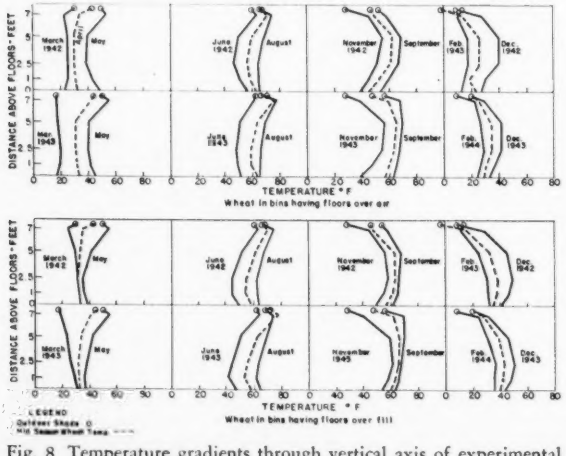

Fig. 8 Temperature gradients through vertical axis of experimental bins

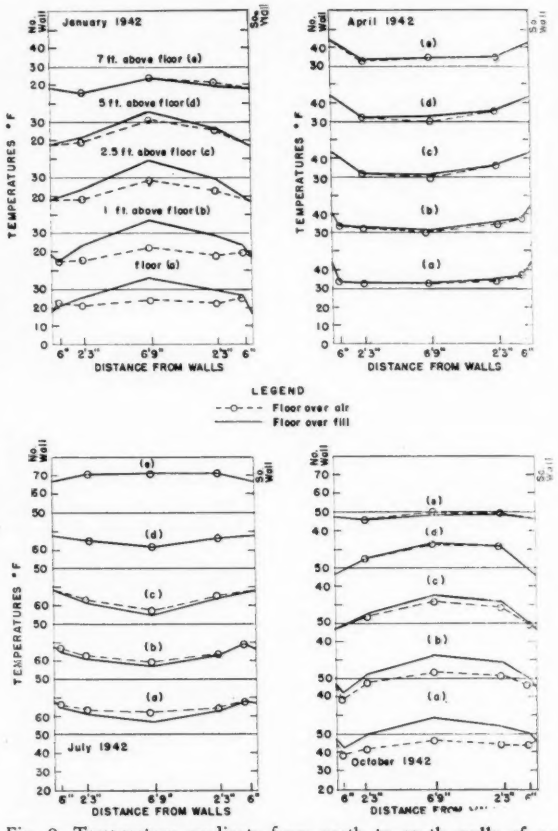

Fig. 9 Temperature gradients from north to south walls of experimental bins

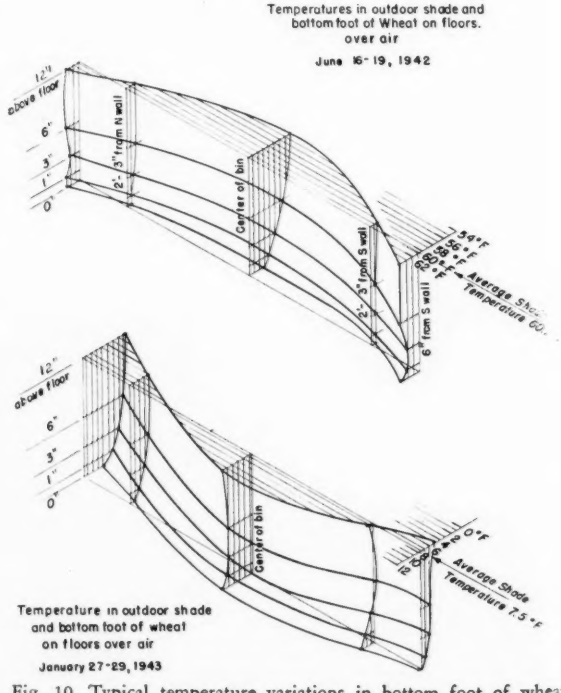
Temperatures in outdoor shade and bottom foot of Wheat on floors.
over air
June 16-19, 1942
Center of bin
Average Shade Temperature 60°F
Temperature in outdoor shade and bottom foot of wheat on floors over air
January 27-29, 1943
Average Shade Temperature 7.5°F

Fig. 10 Typical temperature variations in bottom foot of wheat during summer and winter

Effect of Variations in Available Soil Water on Yield and Quality of Potatoes

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JUNIOR MEMBER A.S.A.E.

ONE of the problems in irrigation is the efficient use of water. Whether water is pumped or obtained by gravity flow from streams or from delivery ditches of an irrigation project, there is time and expense expended during every period of irrigation. It has been thought that more economical use of water could be attained by fewer irrigations at definite soil moisture and plant relationships rather than by applying set depths of water at prearranged intervals of time during the growing season.

Applying set depths of water at prearranged intervals is open to several objections. It does not take into account the soil physical characteristics which would give an indication of the moisture-holding capacity of the soil and the available water for plant growth. If there is a tendency to apply water too often or in too great a volume per irrigation, the water may be lost by deep percolation, draining out of reach of the plant. Weather conditions and type of crop also influence soil moisture extraction.

Hence, it was felt that the plant, according to weather conditions, type of crop, and soil characteristics, would be a good indicator of the depletion of soil moisture — and accordingly of when the moisture should be applied. In the experiments, only when the moisture content of the soil dropped to certain prearranged values was moisture added. These moisture values were determined by frequent soil moisture sampling.

These questions formed the basis for field experiments set up in 1940 and run in 1941 and 1942, and for the later 1942 greenhouse experiment which is being reported in this paper. The greenhouse investigation was set up to check the project objectives as performed in the field trials of 1941. These objectives were as follows:

1 To find the effect of variations in the available water in the soil on the yield and quality of farm crops
2 To determine the consumptive use
3 To determine the rate of soil-moisture extraction
4 To find the frequency of irrigation which will give the best yields and quality.

The Experiment. The top soil (0 to 10 in) from the 1941 field trials[1] was used for the greenhouse study. Since soil types vary in their available moisture content for plant growth, extensive physical examination of soil was made, and the following physical characteristics were determined: (a) permanent wilting point, (b) field capacity, (c) volume weight, (d) mechanical analysis, (e) pH, (f) per cent lime, (g) total salts, (h) depths of each horizon.

Wilting point determinations were made as outlined by Briggs and Shantz[2]. Volume weight was determined by both the soil tube and the paraffin block method[3,4,5,6]. Mechanical analysis was determined by the method described by Bouyoucos[7].

Field capacity was determined by an *in situ* method. Steel cylinders six inches in diameter and one foot long were pressed into the different horizons in the field. The penetrating edge of the cylinders had been sharpened on the outside surface only to reduce compression of the soil. Water was added to the soil surfaces within the cylinders until water drained from a small section of removed soil at the bottom of the cylinder. A drainage period of 24 hr was allowed before moisture samples were taken for field capacity determinations.

The surface horizon which was selected for the greenhouse study was a light brown loam to sandy loam with small pebbles up to ⅛ in in diameter. This soil was sieved through a ⅛-in screen and compacted into the iron tanks to approximately the average volume weight of the soil in the field. It had the following characteristics:

Horizon	Depth in inches (average)	Field capacity (avg), %	Permanent wilting point (avg), %	Volume weight* (avg)
A	10	23.8	10.8	1.574

Available Moisture† of Soil in Inches Per Square Foot of Soil Surface Per Foot of Depth.

Horizon	Per cent available moisture (avg)†	Inches available moisture (avg)
A	13.0	2.45

*Paraffin block method. This gave more consistent results due to small pebbles, etc., which made the soil tube results extremely variable.
†Difference between field capacity and permanent wilting point.

Three irrigation treatments were used in the greenhouse study. The application of water was started when the plants were very young. The three treatments were:

1 *Minimum variations* in the available moisture content of the soil. The average moisture content of the soil shall not go below one-half the difference between the moisture content at field capacity and at permanent wilting point. Whenever moisture dropped to this level, it was replenished to field capacity. Lowest level of moisture in the can in per cent moisture equals $(F.C. - W.P.)/2 + W.P.$

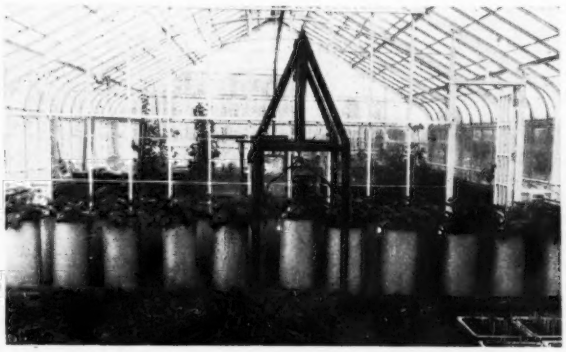

Fig. 1 Potato plants one month old growing in galvanized iron tanks

This paper was prepared expressly for AGRICULTURAL ENGINEERING.

JOHN F. CYKLER is research assistant in agricultural engineering, Wyoming Agricultural Experiment Station.

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2 *Medium variations* in available moisture. Lowest level of moisture in the can in per cent moisture equals (F.C.−W.P.) / 3 + W.P. Whenever moisture dropped to this point, it was replenished to field capacity.

3 *Wide variations* in available moisture. Whenever the average moisture content of the can approached within 5 per cent of the permanent wilting point, it was then replenished to field capacity. Lowest level of moisture in plot in per cent moisture equals (F.C.−W.P.) 0.05 + W.P.

The irrigation work was conducted in the University of Wyoming greenhouse at Laramie, Wyoming, during the spring of 1942. The crop (potatoes) was grown in individual galvanized iron tanks that were one foot in diameter and 30 in in height, holding 105 lb of dry soil.

Seven replicates per treatment were used due to the small space available for this study. The tanks were arranged (Fig. 2) in two rows with a traveling crane running overhead from which the pots were lifted and at the same time weighed. Bliss Triumph certified seed stock was used. Each potato was trisected from the seed to stem end, and disinfected in corrosive sublimate; one-third of each potato was then planted in one replicate of each of three treatments at a depth of approximately 2 in. Soil data and moisture contents at each treatment are given in Table 1.

TABLE 1. WEIGHT VARIATIONS ALLOWED FOR CANS USED IN GREENHOUSE EXPERIMENT

Dry weight of soil in cans	105 lb
Tare of can and hook	15
Total weight	120

Treatment	Weight of can + hook + soil at field capacity, lb	Weight of can + soil + hook when water should be applied, lb
Minimum variation	145	139
Medium variation	145	136
Wide variation	145	133

A greenhouse temperature of approximately 72 F (degrees Fahrenheit) was maintained. The potatoes were planted March 18, 1942, and harvested June 3, 1942. Twice during the experiment a pound in weight was added to the tare of the can plus the soil to take care of the weight of top growth and tubers. This was approximately determined from previous potato studies. A more exact method would be to grow extra potatoes and harvest them during experiment to provide tuber and top growth information. The cans were weighed at least twice a day and water added as per Table 1. The irrigation treatments commenced April 14 and ceased June 1, two days before harvesting.

Results. Table 2 gives data on odd-shaped tubers, top weight, weight of tubers, and tuber set. The analysis of variance was run on tuber-set yields. The tuber set was divided into tubers over 1 in in diameter and under 1 in in diameter. In the analysis on yields, the F value as calculated was 9.69, as compared with the table value of 5.14 at the 5 per cent level. Therefore, the difference between treatments is significant at the 5 per cent level. The minimum variation gave the highest yields, medium next, and wide last. As far as the difference in treatments would vary the tuber set, the analysis shows no significance in either tubers over 1 in or under 1 in.

Table 3 gives the number of irrigations during the irrigating season for the different treatments. The irrigation season has been

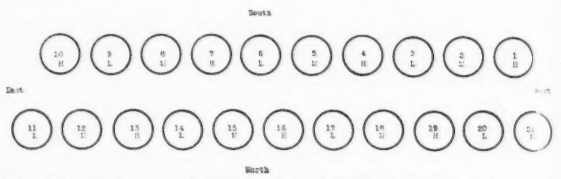

Fig. 2 Arrangement of tanks in greenhouse. Seed pieces from the same potato were planted in the following cans: 1-3; 4-5-6; 10-11-12; 13-14-15; 16-17-18; 19-20-21. Legend: H, wide variation; M, medium variation; L, minimum variation

broken up into three parts—April 14 to April 31; May 1 to May 15; and May 16 to June 1. It will be noticed that in any of these three periods the percentage number of irrigations is about the same for each of the treatments. From inspection of the curves of moisture content against time in days (Fig. 3) — for can No. 9 (minimum variation), can No. 18 (medium variation), and can

TABLE 3. NUMBER OF IRRIGATIONS* DURING IRRIGATION SEASON

Treatment	Total irrigations	Apr 14 to Apr 31		May 1 to May 15		May 16 to June 1	
		No.	Per cent	No.	Per cent	No.	Per cent
Minimum	18.9	4.73	25.1	5.58	29.5	8.58	45.4
Medium	13.0	2.85	21.9	4.00	30.8	6.14	47.2
Wide	9	2.14	23.0	2.71	30.1	4.14	45.9

* Average of 7 replicates per treatment.

No. 16 (wide variation)—it is seen that the rate of the sum of moisture extraction by the plant and evaporation from the surface used as a single value is nearly constant for each treatment. The plants seem to be able to extract moisture from the soil at the same rate, whether the soil moisture tension is high or low, as long as available water is present. The rate of extraction between treatments is nearly constant as indicated by Table 4. The variation is small and further study may show that the rate of extraction is the same for all treatments as long as available water is present and evaporation losses can be evaluated. Cans which are watered more frequently do lose more water through surface evaporation, and this loss will be studied in future work. This surface evaporation loss would conform to actual field practices.

It was found that the higher the soil moisture content the greater the use of water, but this may be explained

TABLE 2. IRRIGATION INVESTIGATIONS; POTATO EXPERIMENTS, GREENHOUSE-SPRING, 1942. FIELD DATA OBTAINED FROM VARIOUS TREATMENTS

Replicates	Treatment	Odd-shaped tubers	No. stems	Fresh wt tops oz	Fresh wt tubers lb	Fresh wt tubers oz	Total water used, lb	Tuber set Number of tubers over 1″	under 1″	total
1	1 wide var.	0	6	11	1	7	107	15	33	48
	2 med. var.	2	6	11	1	10	116	18	24	42
	3 min. var.	5	8	15	1	14	119	27	56	83
2	4 wide var.	0	7	10	1	12	109	18	25	43
	5 med. var.	4	3	12	1	12	117	15	36	51
	6 min. var.	0	6	10	1	10	111	20	23	43
3	7 wide var.	10	4	16	1	5	94	17	19	36
	8 med. var.	2	6	13	1	9	119	17	19	36
	9 min. var.	2	5	10	1	9	101	16	23	39
4	10 wide var.	6	4	12	1	12	115	18	31	49
	11 min. var.	3	4	15	2	4	156	25	43	68
	12 med. var.	1	3	15	1	7	109	13	21	34
5	13 wide var.	1	3	9	1	6	108	20	7	27
	14 min. var.	0	4	16	2	1	143	30	29	59
	15 med. var.	1	4	15	1	14	137	21	46	67
6	16 wide var.	4	2	12	1	4	94	18	32	50
	17 min. var.	1	5	13	1	12	127	23	42	65
	18 med. var.	0	5	15	1	10	112	20	35	55
7	19 wide var.	0	6	13	1	8	118	19	35	54
	20 min. var.	0	5	13	1	14	118	17	30	47
	21 med. var.	0	4	13	1	14	139	28	38	66

Sum of Treatments

	Yield increase, per cent	Yield lb	Yield oz	Number tubers over 1″	Number tubers under 1″
Wide variation	0	10.4	166	125	182
Medium variation	13	11.75	188	132	219
Minimum variation	25	13.0	208	158	246
Standard error of the sum—			8.4 oz		

TABLE 4. AVERAGE SLOPE OF EXTRACTION CURVE

Treatment	A Total average water applied, lb †	B Number irrigations, average	C Number days * interval between irrigations, (avg)	D Water per irrigation, lb †	E Average slope of extraction curve, deg, ‡
Minimum	125	18.9	2.59	6.6	2.55 or 68.5
Medium	121.4	13.0	3.77	9.3	2.47 or 68
Wide	106.4	9.0	5.44	11.8	2.17 or 65.3

* Average number of days interval between irrigations = number of days ÷ total number of irrigations.

† Pounds of water per irrigation = Column A ÷ Column B.

‡ Average slope = pounds of water per irrigation ÷ average number of days interval between irrigations = Column D ÷ Column C.

through greater evaporation loss from the surface. The yield increased with high water levels. The pounds of water used per pound of tubers decreased with higher percentages of water in the soil. The decrease in yields in the wide variation cans may not be due to soil moisture but to the physical condition of the soil at reduced moisture levels.

The average use of water for the various treatments, including evaporation from the soil surface, is as follows:

Treatment	Total avg water use, lb	Pounds per plant per 24 hr	Pounds of water per lb of tuber
Minimum variations	125.0	2.55	9.62
Medium variations	121.4	2.48	10.32
Wide variations	106.4	2.17	10.22

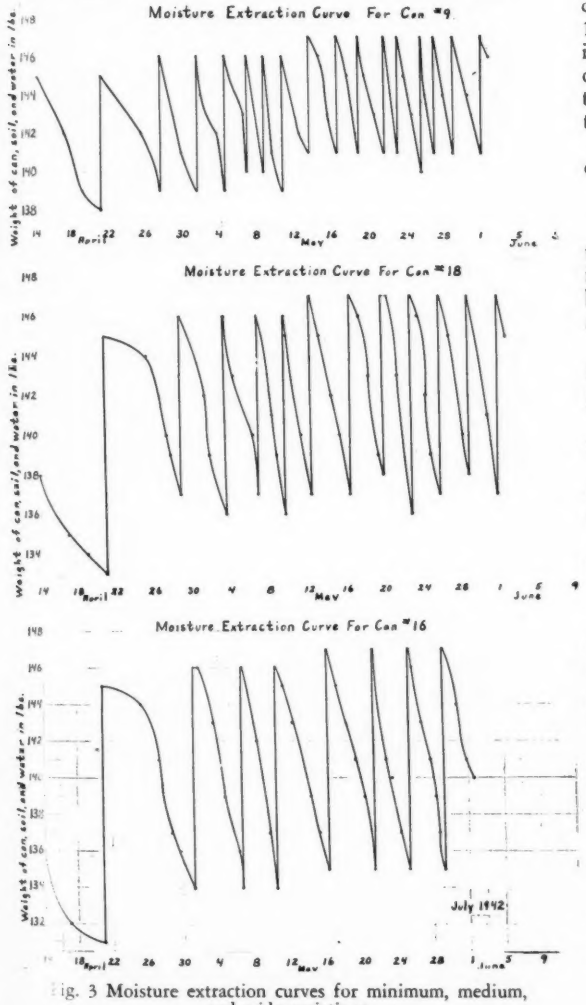
Moisture Extraction Curve For Can #9
Moisture Extraction Curve For Can #18
Moisture Extraction Curve For Can #16
July 1942

Fig. 3 Moisture extraction curves for minimum, medium, and wide variations

There seems to be very little difference in the use of water between treatments on the per day basis, although over a 60-day period the difference between the minimum and wide variations would be rather large. Even though the total water used per plant varies within the treatment, there is almost no significance between yields and water use between treatments.

TABLE 5. PROBABLE ERROR OF MEAN* FOR TOTAL WATER USE AND YIELDS

Treatment	Probable Error of Mean: Total of water used, lb	Yield, lb
Wide variation	106.4 ± 2.38	1.482 ± .051
Medium variation	121.4 ± 3.03	1.678 ± .042
Minimum variation	125 ± 4.82	1.857 ± .0614

*Probable error of mean = Mean value ± $0.6745\sqrt{\frac{\Sigma V^2}{n(n-1)}}$

where n = number of observations

ΣV^2 = sum of the squares of the residuals.

Scofield (see appended bibliography, 19) shows that alfalfa does not make any more efficient use of water when the plants are irrigated sparingly or infrequently than it does when the water supply is continuously abundant. He did show that with low moisture levels the yields are reduced. Meyer and Anderson (see appended bibliography, 18) discuss rate of absorption and transpiration rate. They indicate that within limits the moisture extraction is increased when the soil moisture level is high. Tables for two types of soils show a higher transpiration rate the higher the moisture level up to a certain percentage moisture.

Throughout the study there could be observed no difference in top growth between plants of different treatments.

CONCLUSION

1 High yields of potatoes can be obtained by keeping the water content of the soil at a high level throughout the irrigation season, never letting the moisture content fall below one-half the difference between the moisture content at field capacity and permanent wilting point.

2 Tuber set is independent of the variations in the moisture content of the soil as long as available water for plant growth is present.

3 Top growth is independent of the moisture content as long as available moisture is present for growth.

4 With wide variations in moisture content, water use and yields are decreased. However, consumptive use is increased (pounds of water per pounds of tuber).

5 The rate of soil moisture extraction, when corrected for evaporation, may be a constant for all treatments.

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Why Not More Deep Wells and Fewer Ponds?

TO THE SECRETARY, A.S.A.E.:

I HAVE just returned from the A.S.A.E. annual meeting in St. Louis. While the program was the most important feature, visits with old acquaintances and men interested in my line of work, comparing experiences with different engineering problems in the field, made the trip worth while. I do wish though that there could be more papers or discussions on problems that still confront us in tile drainage. Considering the millions of acres of the finest farm land in the highly settled Middle West that are not producing crops because they are undrained, it would seem to me that emphasis should be placed on reclamation here. Roads, schools, buildings, villages are already established. The projects are largely small, individual ones of a few acres on each farm. They do not involve large public expenditures, but the total acreage that could be reclaimed is staggering. For instance, several authorities have estimated that over two million acres located in the northern half of Iowa and southern half of Minnesota could be put into crop production by adequate undersurface drainage. These acres are highly fertile and are located in good marketing territory.

There is much activity in the promotion of pond building in certain sections, especially southern Iowa and in Missouri. After the St. Louis meeting I visited in western Missouri, mostly in Johnson and Cass Counties. Many new ponds have been built there in the last few years, most of them during the past few months. I cannot understand why so much encouragement is given to pond building, unless there is conclusive proof that sweet water cannot be obtained by deep-cased wells. The stagnant pond water breeds mosquitos, scums over in many cases during the hot weather; milch cows stand in the shallow part stamping to get rid of flies and covering their udders with mud; hogs wallow in it, and ducks and geese polute the water. These ponds cover ground that could be producing crops, and the investment in them is considerable. The only value of the pond, that I can see, is to furnish drinking water to livestock. If an adequate deep well can be secured by drilling in the farm yard, why bother with a pond?

When I first began making visits to this area, nearly twenty years ago, practically all the farmers used shallow-dug wells for most of their water supply, and cisterns with filters in which to store water from the roofs of their houses. Nearly all of the drinking water came from these cisterns which received all of the roof washings, including dirt, bird droppings, etc., washed off during each rain.

During periods of summer drought, and sometimes during long cold spells in the winter with light rainfall, the water in the cisterns became exhausted. The shallow-dug wells also ran dry during times of drought. During one long drought, water was shipped in in railroad tank cars and distributed by trucks.

We made inquiries in the neighborhood but could not locate one deep-drilled well. The local people all told us that no usable water could be obtained by drilling, that there was either no water or that the water contained taints of oil, salt or soda. How they arrived at this conclusion I do not know, as not one could point out a well that had been drilled. I wrote to the University of Missouri and the Missouri School of Mines and both told me that they had no information we could use in determining the risk of securing good water by drilling. A Waterloo, Iowa, manufacturer of well-drilling equipment could not help us either but gave me the names of drillers who lived nearest to the neighborhood.

After much dickering and horse trading, including taking in an old mare and colt and other considerations, a driller undertook the work of drilling a well on my father-in-law's farm. He struck a vein of good, cool water at about 150 ft, which rose up in the casing to 35 ft of the surface. A rotary pump lowered the water only a few inches while running at full capacity for an hour, and the well has given ample water at all times for the past several years. Another well two miles away is now giving cool water with a slightly soda taste, but not at all objectionable. Last winter a third well was drilled about a mile farther west. Water was struck at 145 ft, and it rose in the casing to about 30 ft of the surface. It is sweet and cool and will provide ample supply for all the needs of the farm. So here are three tries and no failures in a territory where the local tradition was that deep drilling could not secure good water.

In this same neighborhood there is much activity in pond building, inspired by various agencies. It would seem to me that the emphasis should be placed on drilling unless reliable information proved definitely that it is impracticable, and that the building of ponds should be the last resort when water cannot be secured through deep wells. To maintain its volume, the pond must have a very dense base, in which case it will have small value in feeding the underground water supply. Other objections to ponds are mentioned in the first part of this letter.

It would seem that reliable data on deep drilling would be very valuable to many localities now suffering from inadequate water supply during period of drought.

Drainage Consultant. W. S. LYNES.

Preservative Treatments for Use on Wood off the Ground

By A. F. Verrall

FAST-GROWN pine with a high percentage of sapwood is now the principal wood used for general construction in the South. When such sap pine is used for exterior purposes, as porch floors, steps, porch rails, and window shutters, it oftentimes is subject to early decay following rain seepage into joints. Consequently it has become increasingly important to practice such decay preventive measures as keeping untreated wood off the soil and using good designs and carpentering to minimize rain seepage into exterior woodwork. Even with good construction it is not feasible to exclude completely water seepage into joints of exterior woodwork, and when naturally decay-resistant wood is not available a preservative treatment is sometimes desirable.

In many localities, particularly in rural areas, lumber commercially impregnated with preservatives is not generally available or its cost may preclude its use in low-cost construction. The present studies were undertaken to secure data on the effectiveness of preservatives applied by brush and soak methods that could be used on the job. Such treatments are recognized as inadequate for severe exposures, as in contact with soil, but it was thought they might be useful in extending the life of non-durable wood under less severe exposures. The exposure methods used were designed to give fairly severe decay hazard by rain seepage but to avoid termite attack and other factors concomitant with soil-burial tests but absent in a well-designed building.

Preservatives Used. Three preservatives were used: pentachlorophenol, copper naphthenate, and phenyl mercuric oleate. These were chosen because they are available in commercial quantity in concentrated forms that can be diluted on the job with the lighter petroleum solvents, can be applied to seasoned wood without causing swelling, and after a relatively short time required for evaporation of the oil carrier leave a paintable surface. Kerosene was used for the dilutent in these studies. The approximate concentrations used were: 5 per cent pentachlorophenal, 0.2 per cent phenyl mercuric oleate, and 4.5 per cent copper naphthenate (0.5 per cent copper) for soak and 18 per cent copper naphthenate (2 per cent copper) for brush treatment.

For soak treatment the wood was immersed in enough solution in a galvanized vat to cover the wood to a depth of 2 to 8 in, for 15, 30, or 60 min. Brush treatments were applied with a paint brush, allowing the solution to flow freely on the surface. A second coat was applied about an hour after the first. All treating was done with solutions at air temperature.

Test Units. Three types of test units were used (Fig. 1). The "post" unit consisted of a 13-in length of 2x4. The "rail" unit was a 12-in post as above but with a 12-in, 2x4 arm nailed at a 45 deg angle midway up on the post. The "shutter" unit was a simple 16x30-in window shutter composed of three vertical 1x6-in tongue-and-groove pieces nailed to two 1x4 rails.

All test wood was southern yellow pine with a moisture content below the fiber-saturation point at the time of treatment. The range in wood characteristics was sufficient to include most conditions likely to be met, as shown in Table 1.

TABLE 1. THE RANGES AND AVERAGES OF RINGS PER INCH, PER CENT HEARTWOOD, AND PER CENT SAPSTAIN IN THE TEST UNITS

Test	Rings per inch	Per cent heartwood	Per cent sapstain
Rail Test 1	2-11, avg 4.7	0-60, avg 5.1	0
" " 2	2-9, avg 4.7	0-90, avg 9.2	0-75, avg 4.6
Post Test 1	2-13, avg 6.5	0-80, avg 16.3	0-90, avg 7.6
" " 2	4-21, avg 10.3	0-4, avg 9.2	0
Shutter Test	1-10, avg 5.0	0-25, avg 1.8	0

The wood was cut in such a manner that for each treatment in the rail and post tests there was an equal number of pieces from each length of 2x4 used. For the shutter test the individual pieces were completely randomized among the treatments and not matched as in the other tests.

The wood was cut to size before treatment. The units containing more than one piece of wood were assembled by nailing after treatment. Seven to 27 days after treating, the assembled units were brush painted with two coats of white exterior oil paint. The rail and window shutter units were painted on all exposed surfaces. The tops, as well as the unexposed bottoms, of the post units were left unpainted. In painting, the joints were not sealed so that rain water would seep into the test units.

For exposure the units were nailed to 2x4 sills elevated 18 to 24 in above the ground for the rail and post tests and 5½ ft for the shutter test. The sills for the rail and shutter tests were pressure creosoted; for post test No. 1 they were untreated pine, and post test No. 2 pine pressure treated with Wolman salt. Exposure was under part shade of hardwoods at the Harrison Experimental Forest, near Saucier, Miss. (Fig. 2).

Results. Inspection of the exteriors of the test units after 1, 2, 3, and 4 years' exposure disclosed steadily increasing decay in the untreated units but no or little decay in the treated units. The ratings assigned after 3½ to 4 years are shown in Table 2. Although no culturing was done, it seems probable that much of the observed decay was caused by *Lenzites saepiaria* because this fungus fruited in abundance on the untreated units. Fruiting of a few other fungi was occasionally present.

Because the units were painted, decay usually could not be detected until it had reached an advanced stage and decay ratings based on external evidence were open to question. Therefore, after 3½ to 4 years' exposure one-fifth of the units of each treatment in the post and rail tests were

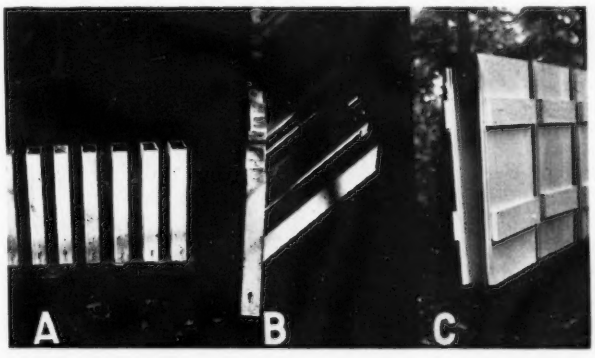
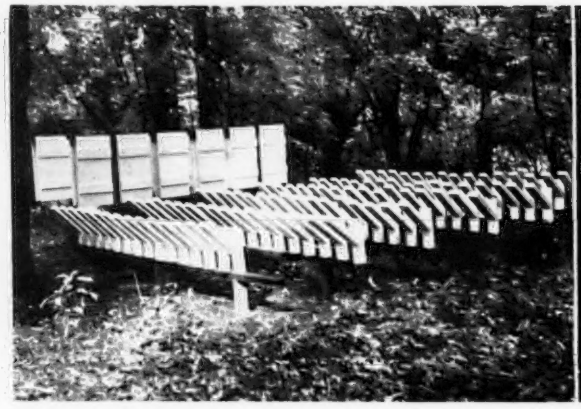


Fig. 1 The three types of test units used in the tests reported by Mr. Verrall; A, post test; B, rail test, and C, shutter test

A. F. VERRALL is pathologist, division of forest pathology, Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture, in cooperation with the Southern Forest experiment Station.



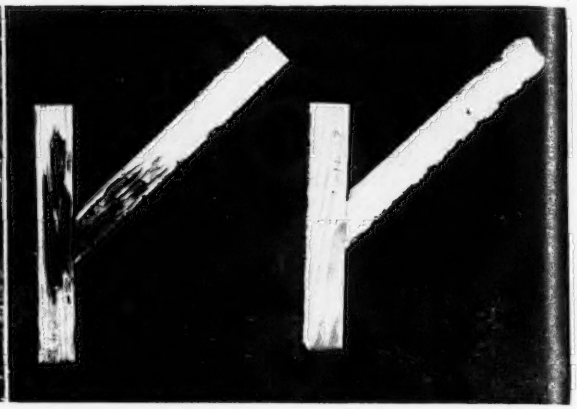


Fig. 2 *(Left)* General view of test plot showing rail and shutter test units exposed on elevated sills. The post test units were later exposed on similar sills. Fig. 3 *(Right)* Two typical "rail" units ripped longitudinally after 4 years' exposure showing heavy decay in untreated (left) and no decay in unit soaked for 30 min in 5 per cent pentachlorophenol (right)

TABLE 2. DECAY RATINGS OF TEST UNITS BASED ON EXTERNAL EVIDENCE OF DECAY*

Treatment	Total number of units	Type† and number of tests	Decay after 3½-4 years' exposure: Number of units showing decay	Decay rating‡ average
15-min soak				
5 per cent pentachlorophenol	25	R 1	0	0
30-min soak				
5 per cent pentachlorophenol	101	PRS 5	1	+
0.2 per cent phenyl mercuric oleate	25	P 1	2	0.2
4.5 per cent copper napthenate	20	R 1	0	0
60-min soak				
5 per cent pentachlorophenol	34	RS 2	1	+
Brush treatment, 2 coats				
5 per cent pentachlorophenol	20	R 1	0	0
18 per cent copper naphthenate	20	R 1	0	0
Untreated	104	PRS 5	94	2.5

*The results of all 5 tests are combined. In the individual tests the untreated ranged from 1.6 to 3.4 in average decay rating.

†P, R, and S represent post, rail, and shutter tests, respectively.

‡Ratings on a scale of 0 (none) to 5 (destroyed); "+" indicates a trace.

removed for detailed decay ratings. The units removed were matched among treatments. The units were disassembled and each piece ripped longitudinally. The surfaces exposed by ripping were classified as to decay intensity into six classes (0, 2, 4, 6, 8, and 10) from none to practically destroyed. The 2 class represented slight discoloration or suspicion of decay but no softening. The area involved in each intensity class was estimated in 1/10 units of the total area. The decay rating assigned was the summation of the products of intensities and the area involved in each intensity; thus they were on a scale of 0 (none) to 100 (completely decayed). For the rail-test units the ratings for the two pieces of each unit were averaged for the final rating. The ratings based on internal decay are listed in Table 3. Typical condition is shown in Fig. 3.

TABLE 3. DECAY RATINGS OF THE TEST UNITS BASED ON DECAY EXPOSED BY LONGITUDINAL RIPPING OF A 1/5 SAMPLE

Test	Number of units opened	Decay rating after 3½-4 years' exposure*: Post test No. 1	Post test No. 2	Rail test No. 1	Rail test No. 2	Average
15-min soak						
5 per cent pentachlorophenol	5	—†	—	1.0‡	—	1.0
30-min soak						
5 per cent pentachlorophenol	19††	0.23‡	0.8‡	1.9‡	0.4‡	0.8
0.2 per cent phenyl mercuric oleate	5	—	1.0‡	—	—**	1.0
4.5 per cent copper naphthenate	4	—	—	—	0.4	0.4
60-min soak						
5 per cent pentachlorophenol	5	—	—	1.2‡	—	1.2
Brush treatment, 2 coats						
5 per cent pentachlorophenol	4	—	—	—	0.8‡	0.8
18 per cent copper naphthenate	4	—	—	—	0.3‡	0.3
Untreated	19††	25.2	49.2	53.8	46.5	43.5

*Ratings on a scale of 0 (none) to 100 (completely decayed).

†A dash indicates not included in the test.

‡No evident softening, rating based on slight discoloration that may have been water stain, or in the rail tests what may have been creosote stain where in contact with the creosoted sill.

**Slight softening in one piece.

††Five pieces from each test, except rail test No. 2 from which four pieces were removed.

By the end of the second year of exposure it was evident by even a casual inspection that the paint on the untreated units was much more discolored than on the treated units. Much of this paint discoloration appeared to be due to the black mold so common on exterior paint in the Gulf States. Some of it, however, appeared to be due to stain and decay working outward from the underlying wood. The units in Rail Test No. 1, Post Test No. 1, and the Shutter Test were classified, after two years' exposure, for paint discoloration. The classes used were 1 (light discoloration), 2 (medium), and 3 (heavy). The results are listed in Table 4.

TABLE 4. THE RELATIVE AMOUNT OF DISCOLORATION OF THE PAINT ON WOOD TREATED WITH 5 PER CENT PENTACHLOROPHENOL AND ON UNTREATED WOOD AFTER 2 YEARS' EXPOSURE

Test	Average Discoloration*: Treated Wood	Untreated Wood
Rail Test No. 1	1.8	2.9
Post Test No. 1	1.2	1.8
Shutter Test	1.0	2.5

*1 (light), 2 (medium), 3 (heavy).

CONCLUSIONS

Cold soak and brush treatments with pentachlorophenol and copper naphthenate and a cold soak treatment with phenyl mercuric oleate gave good protection to southern yellow pine sapwood in specially designed test units exposed outdoors, above ground, and subject to rain seepage at joints. This was true whether the treated units were in contact with sound treated or untreated, and now decaying, exposure sills; on both end grain and side grain in the test joints; and even when the side grain was punctured by subsequent nailing. Although the test units have been exposed for only 3½ to 4 years and further records are needed to determine the maximum benefit to be derived from the treatments, the data indicate that short-period soak and brush treatments will be useful in extending the life of nondurable woods for uses where *(Continued on page 369)*

Vitamin D Potency of Germicidal Radiation

By Lawrence C. Porter
FELLOW A.S.A.E.

FOR some time we have suspected that germicidal radiation (2537 Angstrom units) will produce vitamin D and prevent or cure rickets.

The medical profession has for many years assumed that the production of erythema is a direct indication of the production of vitamin D and consequently an indication of the health value of ultraviolet radiation.

The potency of various wavelengths of ultraviolet radiation in the production of erythema is well established. The studies of early investigators and later studies by the General Electric Company's Light Research Laboratory check closely as to 2967 A (Angstrom units), being close to the most potent wavelength for the production of erythema, and they also agree that there is a secondary peak close to 2537 A. Just what the per cent effectiveness of this short-wave ultraviolet is compared to 2967 A, is, however, questionable. Earlier investigators rate it at approximately 55 per cent of 2967 A. More recent data indicate that it may be higher.

Whether the same relation between production or erytherma and production of vitamin D holds for both 2967 and 2537 A radiation is not yet proven. However, we have been receiving an increasing number of reports of stronger, healthier poultry under germicidal radiation than without it. Many of these reports come from disease-free flocks and must therefore be attributed to the vitamin D potency of germicidal radiation rather than to its air disinfection properties.

Hess and Anderson irradiated two groups of rachitic rats with equal amounts of radiant energy; one group received energy between 2900-3660 A, the other between 2500-2800 A. They reported that "While both groups were cured of rickets, it was found that the band of shorter wavelengths proved more potent than that of longer wavelengths". ("The Antirachitic Activity of Monochromatic and Regional Ultraviolet Radiations," Hess and Anderson. Jour. Amer. Med. Assn., vol. 89, p. 1222, 1927.)

Prof. John W. Bunker, Director of Biological Research and Professor of Physiology and Biochemistry at the Massachusetts Institute of Technology, has determined the amount of ultraviolet energy at different wavelengths required to produce equal (++) healing of rachitic rats. He reported as follows: (Bunker and Harris, New Eng. Jour. Med., 215, 165, 1937):

Angstrom units	Ergs required to induce ++ healing
3035	900,000
2967	420,000
2804	600,000
2652	660,000
2537	775,000

In other words, he found 2537 A to be 54 per cent as effective in actual cure of rickets as 2967 A which agrees closely with the earlier erythemal curves.

Dr. Arthur Knudson, at Albany Medical College, and Frank Benford, in the General Electric Research Laboratory at Schenectady, in 1945 irradiated rachitic rats at a distance of 3 ft with (1) an S-1 sunlamp equipped with reflector, (2) a bare 15-w germicidal lamp, and (3) a bare 20-w fluorescent sunlamp. Dr. Knudson reported the following:

Lamp	Exposure	Healing
S-1 sunlamp	10 min.	0.1
"	20 "	0.7
"	40 "	1.4
"	50 "	1.9
15-w germicidal lamp	10 "	1.9
"	20 "	2.2
20-w fluorescent sunlamp	20 "	no healing
"	60 "	1.0
"	100 "	1.4
"	140 "	2.0

These tests were carried out according to standard assay procedure for vitamin D. For comparison 35 mg. of standard cod liver oil preparation gave a healing of 1.9 which is equivalent to 4-USP units. The table indicates that the bare 15-watt germicidal lamp is approximately 5 times as potent as an S-1 sunlamp with reflector, and 14 times as potent as a bare 20-watt fluorescent sunlamp.

At Ohio State University in 1945 the bottoms of the feet of 15 baby chicks were exposed for 5 minutes daily at 1 to 1½ inches to a bare 15-w germicidal lamp for a period of 6 weeks. Dr. A. R. Winter reported as follows:

	Avg. weight	% Bone Ash
Exposed chicks	404 gms.	43.6
Unexposed chicks	309 "	33.9

All sources of vitamin D were withheld from both lots of chicks. Dr. Winter states that the bone ash of the exposed group was practically normal. The unexposed group showed indications of rickets, lacked normal development, and had low bone ash characteristic of rachitic birds.

Dr. Bruckner, head of the Poultry Department at Cornell University, made similar statements regarding his tests of 2537 A radiation.

Therefore it is evident that 2537 A radiation does create vitamin D in sufficient quantity to prevent and cure rickets.

It is perhaps unfortunate that these data were not available before the variously called Poultray, Germicidal + or Germi-SOL lamps were introduced. In the absence of such data, and in view of the wide acceptance of sunlamps for health and of germicidal lamps for the control of the spread of disease, it seemed logical to combine the two in the Germi-SOL lamp.

However, now that we know definitely that 2537A radiation does cure rickets and has a potency of at least 55 per cent of 2967A, there is little, if any, excuse for the Germi-SOL lamp, because even at 55 per cent the germicidal lamps emit more antirachitic radiation per watt than S-1 or S-4 sunlamps, or the Germi-SOL lamps. For example, the 15-w germicidal lamp emits 2,900,000 microwatts of ultraviolet below 2800 A. Using a factor of 55 per cent that gives 1,600,000 microwatts of erythemal energy, or 160,000 E-vitons. The S-4 sunlamp emits only 2,100,000 microwatts between 2800 and 3200 A, which erythemally weighted gives 50,000 E-vitons.

The E-viton emission of the various sunlamps and germicidal lamps is shown in the following table:

Lamp	E-vitons	E-vitons per watt
S-1 sunlamp	68,000	170
S-4 "	50,000	500
RS-4 "	35,000	350
RS "	25,000	91

This paper was prepared expressly for AGRICULTURAL ENGINEERING.

LAWRENCE C. PORTER is illuminating engineer, Nela Park Engineering Division, General Electric Co.

Lamp	E-vitons	E-vitons per watt
4-w germicidal	33,500	8,375
8-w "	84,000	10,500
15-w "	162,000	10,800
30-w "	402,000	13,400
*20-w fluorescent sunlamp	45,000	2,250
*40-w " "	100,000	2,500

*Not yet commercially available.

At present the American Medical Association does not approve the use of germicidal radiation for human health purposes except under the direction of a physician. However, there are no such restrictions applying to animal and poultry use where direct irradiation with germicidal lamps is accepted practice.

Since it is poultry practice to irradiate the birds directly, it is apparent that germicidal lamps are the best sources of ultraviolet available both from the standpoint of air disinfection to reduce the spread of disease as well as the production of vitamin D to improve the health of the birds.

Preservative Treatments for Use on Wood off the Ground

(Continued from page 368)

they will be subject to rain seepage at joints. The treatments used could be easily applied on the job by the ordinary builder. After 3½ to 4 years' exposure there was no appreciable difference in effectiveness between the soaked and brush-treated units, or among the 15, 30, and 60-min soaking periods. It is thought that eventually differences may appear, particularly between the soak and brush treatments.

There is some evidence that these treatments not only prevent early decay but also are useful in retarding discoloration of paints laid over the treated wood. This retardation, however, was not sufficient to warrant depending on a preservative in the wood to the exclusion of other control measures such as composition of the paint, drying rate, glossiness, and the use of toxicants in the paint, for locations where paint molding is severe.

It is not thought that the results of these tests warrant the use of the treatments for such severe exposure as soil contact, or that these treatments should be used where lumber properly impregnated by commercial treating concerns is available. However, when non-durable wood must be used for exterior woodwork subject to rain seepage at joints and more thorough impregnation treatments are not available, the test results indicate that considerable benefit can be expected by short-period soak and brush treatments with certain preservatives. It must be remembered, however, that these treating methods afford only surface protection, and treatment must follow cutting the lumber to size and shape so that untreated wood is not exposed. The preservative should be applied to all surfaces of the wood. Brush treatments applied after assembly would ordinarily be ineffective because the most vulnerable points, i.e., the joints, would be inadequately treated. For long members, which cannot be completely dipped conveniently, best protection would probably result from soaking the ends for three or more minutes to get good penetration of the more vulnerable end grain and then brush treating the flat surfaces.

The treatments used in these tests would be expected to be much less effective on wood green at the time of treatment. For best penetration and absorption the wood should be air-dry before treatment.

Individual Responsibility

IN ALL our talk and love of freedom, the quality of individual responsibility inherent in it should not be overlooked. One must be prepared for this responsibility — he must have a prepared mind for his work — an alertness to the scientific problems and possibilities of his day. Thus the thought that should be left with students everywhere is the value of preparedness to justify our great heritage of democratic procedure. One of the richest assets which any graduate can take with him when he leaves college is the well-established habit of "doing a day's work in a day," of meeting his obligations on time, and appreciating that, whatever is genuinely gained and held to be truly worth while, is attained through a day-by-day best and willing endeavor. True success is merited and not found by accident. This means preparation and constant training, with the student making every day count toward the best of which he is capable.

Today is a time when intelligence, courage, and sustained effort, together with discipline, are indispensable. In the classrooms and laboratories, one learns to school himself to a self-imposed regimen of discipline in study and thought. He does this willingly, knowing that failure to do so will leave him by the wayside. These are habits which attend the truly successful engineer throughout his life.—From "Engineering Evolution from War to a Peacetime World," by L. K. Sillcox in "Mechanical Engineering" for February, 1946.

"ASSEMBLY LINE" POTATO HARVESTING

Two brothers, Robert H. and Russell K. Miller of Multnomah County, Oregon, have adopted the assembly-line technique of modern industry to the most backbreaking of all farm jobs, namely, harvesting (diggin') potatoes on their 600-acre potato "factory". The innovation shown in these pictures — a potato "combine" — digs, sacks, and loads the potatoes in a single operation. Manned by a 9-man crew, including drivers of the trucks which haul the sacked potatoes from the field, the combine processes 1226 sacks of potatoes per day. The potatoes are dug and elevated to a sorting rack where they are brushed, graded, and placed on a conveyor which elevates them to the sackers who load the sacks on trucks which move alongside the combine

Report of the Secretary-Treasurer for 1945-46

To the Council and Members of the
American Society of Agricultural Engineers:

THE A.S.A.E. scene this past year has been quite reminiscent, in some respects, of the period following the ending of World War I more than a quarter century ago. Now, as then, we are experiencing a ground swell of new interest generally in agricultural engineering, and of new and revived interest among members in our Society activities.

Now, as then, our members — this time around 25 per cent in all — are returning from their war jobs, ready and eager to get going again in their professional field. Indeed, it's been a grand feeling, seeing them return these past months, compared with that experienced 3, 4, and 5 years ago when they were headed in the other direction! And, in passing, let us not neglect to be profoundly grateful that most of our members *are* returning. Only a very few of them have paid the supreme sacrifice.

I want to take you back for a brief look at a few of the important forward steps we took following the close of World War I. Then our society was just entering its second decade, and we were keenly conscious of the need to win recognition for what we had to contribute to agricultural science, and as a separate and distinct branch of the engineering profession.

In September 1920, to replace the "Transactions" published annually ever since the Society had been founded in 1907, President Frank N. G. Kranick and Secretary J. B. Davidson, with Council approval, decided to launch our monthly journal, AGRICULTURAL ENGINEERING. That was a most significant and timely step.

The Society started the year 1921 with its first paid secretary, in the person of Frank P. Hanson. That was another big step; and four years later, in 1925, the office of secretary-treasurer was put on a full-time basis.

Also in 1921, the first of our divisions was organized — the College Division — followed shortly by the Land Reclamation, now the Soil and Water Division. The next year, 1922, the Power and Machinery and the Farm Structures Divisions were added, and in 1925 the Rural Electric Division.

Those were all important, bold steps for a young society with around 300 members to take in those days, but it was a time bright with promise for the future of agricultural engineering, and the wisdom of those forward steps proved later to be well founded.

Now we are again in a situation somewhat comparable to that of 25 years ago; but our "land of promise" appears to be even brighter and to possess still greater possibilities than it did then. Now we are larger in number and better prepared to make the most of our opportunities. In A.S.A.E. you have a made-to-order organization which you yourselves have built, and through which *together* you can advance your profession to new heights of influence and accomplishment. It is not possible to chart the Society's future course in detail, at least over any considerable period; that must be done as we progress and as the path ahead unfolds to view. One sure thing we know — our direction. It is always forward!

Personnel Service. Since it has been so much in the forefront of our headquarters' activity these past months, I shall mention first the Personnel Service. Many of those returning from war service to civilian life were without actual jobs in sight. Could the Society help them? Some had former jobs to which they could return, or knew of others that were open to them, but they wanted to look around a bit before deciding what to accept. What did the Society know about available openings?

Our answer to these questions has been the Society's Personnel Service, an outgrowth of the employment service we have conducted in past years, combined with an activity of a special committee of the College Division designed to assist discharged servicemen in finding employment. Close to 75 per cent of those using this service have been men coming out of the armed forces, a majority of whom had had little or no previous professional experience.

Many of you are already familiar with the mechanics of this service, the basic feature of which is a listing of pertinent information on men available and positions open. Each listing is confined to a single sheet, duplicate copies of which are made for distribution to prospective employers or employees, as the case may be. Notices of these listings are also carried in the Personnel Service Bulletin in the Journal.

From the letters received from those using the service, it is apparent that its inception, in its present form last year, was most timely and that through it a goodly number of satisfactory business connections have been made. But the experience has demonstrated that the service as now conducted should be continued as a regular Society activity, and that is what is intended. No charge has been made for this service, and none is contemplated.

Because the need for agricultural engineers appeared to be much greater than the supply, the use of the Personnel Service was not denied to any graduate agricultural engineer, whether or not he was a member of A.S.A.E. Incidentally, it is interesting to note that many non-members using it have expressed their appreciation by applying for membership. It has indeed made new friends and better friends for the Society.

All in all, the conduct of the Personnel Service has been an exceedingly gratifying experience to us at Society headquarters.

* * *

Membership. The grand total, according to the latest count (June 20), was 1702. This is divided among the various grades of membership as follows: Honorary Members, 3; Fellows, 77; Members, 888; Junior Members, 364; Associates, 370.

For a few months following the active entry of the United States into World War II, more members resigned than were enrolled. We have no record in actual figures, but the number, however, was not large.

Then the membership curve started climbing again and has continued to do so since; in fact, I doubt if it has ever been as steep in all Society history, as it has in recent months. You have probably noted it in the longer lists of applicants in the Journal.

This increased enrollment has come mainly from three sources: (1) About two years ago we began noticing greater interest in our Society activities on the part of men with industry and other business connections, which indicated to us a trend on the part of private enterprise to direct a substantial part of expanded wartime productive capacity toward agricultural "pastures" when the war ended. This interest was reflected in our membership enrollment. (2) Members who resigned at the outset of the war because of induction into military service, or for other reasons, began about a year ago to indicate interest in having their memberships reinstated. We haven't kept count, but quite a number of former members are now on the active rolls again. (And, I should like to say, in passing, it's always a pleasure to welcome new members to our A.S.A.E. family, but an even keener one is to greet the return of a former member.) (3) The third main group that has contributed to increased member enrollment consists of the three or four years' "grist" of ag engineering graduates who joined the armed services on or soon after graduation. When the war ended and they began receiving their discharges and finding jobs in our field, with or without the help of our Personnel Service, their applications for membership started coming in. Incidentally, inasmuch as these men could have transferred from membership in our student branches to Junior membership in the Society, without payment of a transfer fee — had they on graduation gone into agricultural engineering work instead of into the job of helping to fight a war — we are now waiving the fee as they are discharged from war service and apply for admission to membership.

The Society continues to enroll, and will always heartily welcome into membership, those who were trained in other branches of engineering or science and who are now in ag engineering work, as well as those who are not engineers but whose work is closely related to that of ag engineers. However, with future enrollment in agricultural engineering curriculums at the land-grant colleges greatly exceeding that of prewar days, as now seems certain, it is reasonable to expect that enrollment of these young men as A.S.A.E. members will increasingly become our chief source of new members.

* * *

A brief digression will be injected here, because it is believed our members will be interested in a bit of long-distance membership promotion in which the Society engages. We refer to the booklet, entitled "Agricultural Engineering As a Professional Career," with which most of you are familiar.

First written in 1932 and furnished by the Society to agricultural engineering departments of the state colleges as a means of acquainting prospective students with what agricultural engineering has to offer, this booklet has since been rewritten and revised under the skilled pen of Walter B. Jones, and is receiving wide distribution. In 1944 and 1945 Science Research Associates of Chicago purchased more than 10,000 copies of it for inclusion in vocational guidance kits which they furnished under contract to the Army, and last January we supplied 4000 copies to the Army Service Forces for similar use. In addition, quite recently orders have been placed by college agricultural engineering departments for several thousand copies, many of which I find are going direct, or through agricultural education departments, to Smith-Hughes teachers of vocational agriculture for distribution to high school pupils.

Many of the boys thus reached — probably most of them from farm homes — will one day emerge as graduate ag engineers, and we believe that their early contact with the Society through the medium of the "Career" booklet may help pave the way to active A.S.A.E. membership.

* * *

Meetings. Now once more after the lifting of wartime restrictions, the Society is enabled to proceed with plans for such meetings as are deemed necessary to meet the desires of its members and the needs of their work. The cancellation of the 1945 annual meeting, with only meetings of the Council and Cabinet and an annual dinner as tokens of the event, was followed with a successful one-day fall meeting at Chicago last December. The one other national meeting during the past Society year was the barn hay-curing conference at Purdue University in January.

Four regional meetings were held during the year: The North Atlantic Section at New York in November, the Southeast Section at Birmingham and the Pacific Coast Section at Sacramento in February, and the Southwest Section at Fort Worth in April.

The following state meetings were held: The Georgia Section held a one-day meeting last month; the Minnesota Section met in June a year ago and last March; the Pennsylvania Section held a two-day meeting last October and another earlier this month, and the Tennessee Section met in November and again last month.

Of our two local sections, the Chicago Section held four dinner meetings, in October, December, March, and June, and the Washington (DC) Section continues to hold its monthly luncheon meetings during nine months of the year beginning in September.

Aside from the general sessions of annual and fall meetings, which are the responsibility of the Meetings Chairman — i.e., the chairman of the Meetings Committee — the programs for the various sessions of national meetings are arranged by the respective chairmen of our five divisions — the Soil and Water, Rural Electric, Farm Structures, Power and Machinery, and College Divisions. These division chairmen and the Meetings Chairman make up the Meetings Committee. Programs for section meetings are usually arranged by section officers acting as program committees. Credit for A.S.A.E. meeting programs, that seem to this observer to be in general worthy of the grading "excellent," belongs to the individual members who happen to occupy the offices referred to.

Members of a profession, to keep abreast of progress and thereby render most effective service in their field, need to get together at intervals to exchange information and views on matters of common concern. While such contacts may be highly informative, and from that standpoint alone well worth while, it is the inspiration we derive, or the stimulus to revived interest and better work on the part of the individual, that makes them by far of greatest value. It is believed that our A.S.A.E. meetings have measured up to the criterion implied in that statement.

Our meetings constitute a highly important activity, and not only the Meetings Committee and officers of the Society, but also members at large need to be constantly alert to possible ways and means whereby they can be made to serve us even better than they do now.

Our fall and annual meetings, from all we can see now, will continue to be fixtures in our meeting setup. Can they be given new form to meet your requirements more effectively? We'll continue to find room for improvement, and your comments and suggestions will always be welcome.

We foresee a growing need for more special meetings — that is, meetings that will permit more concentration on new developments or pressing problems than is usually possible in our regular national and section meetings. The recent barn hay-curing conference is a typical example.

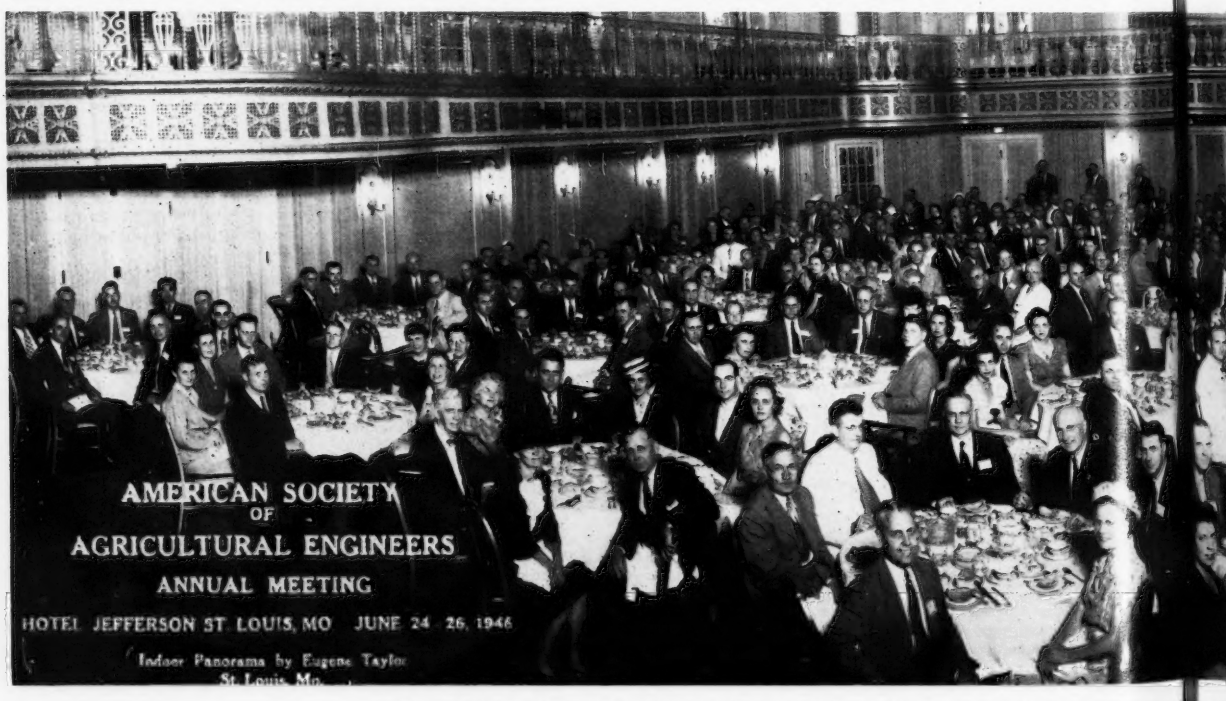
These special meetings may be either large or small; and they may deal with matters national, regional, or local in scope and interest, but in any case they will be mainly for the purpose of benefitting groups of members concerned with certain specialized lines of activity. Responsibility for programming and conducting such meetings would in most cases, at least, logically belong to our divisions, sections, and committees, on the basis of either separate or joint sponsorship by these groups. (It would perhaps be well to mention also, since most of us are not averse to recognition for our good works, that such activity would provide participating individuals excellent opportunities for distinguished service in Society affairs.)

* * *

Sections. President Long helped to stimulate greater interest this past year in organizing new sections, in a special letter to key members in several states where it seemed propitious for establishing sections. As a result, two new state sections have been organized — the Missouri Section in March and the Virginia Section this month. Others will follow. Also, the Council has just approved a petition of members residing in Oregon, Washington and Idaho for authority to organize the "Pacific Northwest Section," to comprise the territory of those three states.

The Society now has a total of 13 sections: Five regional — North Atlantic, Southeast, Southwest, Pacific Coast, and Pacific Northwest; 6 state — Georgia, Minnesota, Missouri, Pennsylvania, Tennessee, Virginia; and 2 local — Chicago and Washington, D. C.

The activity of our sections has been confined practically entirely to holding meetings devoted to specific problems and interests of members in their respective areas and localities, thereby providing more opportunity for contact among members, especially those who may find it difficult to attend national meetings. The usefulness of the sections to members and their value to the parent Society increase as our membership increases and agricultural engineering work expands. And this hints, incidentally, another section activity, namely, membership promotion, in which all sections en-



Most of the distinguished-looking, good-natured folks in the picture on these two pages are

gage more or less automatically but in which there is still plenty of room for expansion.

It would seem that the stage is set, now that our Society has attained a greater degree of maturity and that larger opportunities are open to our profession, for the sections to play a much larger role henceforth in our activities, as well as in the development of our profession.

Committees. A considerable revival of interest in committee work is becoming apparent as wartime pressures are relaxed, as members return from the armed services, and as agricultural engineering work in general gets back to what we choose to call a more normal state. In spite of the fact, however, that our committees were less active during the past few years because of wartime interruptions, it should be pointed out that some of the finest examples of committee work we have ever had in the Society occurred during the war years.

It seems to me that no Society activity offers opportunity for so great a degree of individual initiative and accomplishments as does committee work. There are so many things that committees of the Society can do to benefit the profession in general — *and* participating members in particular. Arranging programs for Society meetings is one of them, and the recent barn hay-curing conference sponsored by the Committee on Hay Harvesting and Storage is a good example. This committee has rendered distinguished service, its members have benefited personally, and a worth-while contribution has been made to an important new development in our field.

There is a wide-open field for committee activity in compiling reference data in convenient form on all phases of agricultural engineering — also in preparing and proposing reports, recommended practices, standards, codes, formulas of various kinds.

Society officers (and that includes division chairmen) welcome proposals from individuals or groups for specific lines of committee activity. In fact, it has been our observation that committee work will likely be more successful if the initiative comes from one or more members who see the need and are willing to assume sponsorship for the activity proposed. To any member or group having in mind a committee project they would like to see get under way in the Society, you have a standing invitation to submit a proposal on it. You will probably be surprised at the ready response you get.

Also, both separate from and in connection with our regular committee work, there is need for individual members — we might call them "sponsors" — to assume responsibility for certain specific projects or lines of work, much of which, of course, would be preliminary to organized committee work. This sort of activity has the advantage of providing opportunity for more members to participate in Society affairs, and from that standpoint has interesting possibilities. While this idea is not entirely new in the Society, it would seem to open up many possible avenues of activity which we might well explore.

Council and Cabinet. It has been our experience that many members like to be reminded occasionally of how the Society functions. Without undertaking to cover the whole Society organization, a brief "refresher" on the Council and Cabinet will be included as a part of this report.

Our A.S.A.E. activities are supervised by a board of directors, called "The Council," which functions under a constitution adopted by the members. Actual administration of our affairs is delegated to the Secretary, who is the executive officer of the Society serving under the direction of the Council.

The Council consists of the President, six Councilors, and the two junior Past-Presidents — a total of nine. A President and two Councilors are elected each year, and each serves a term of three years on the Council.

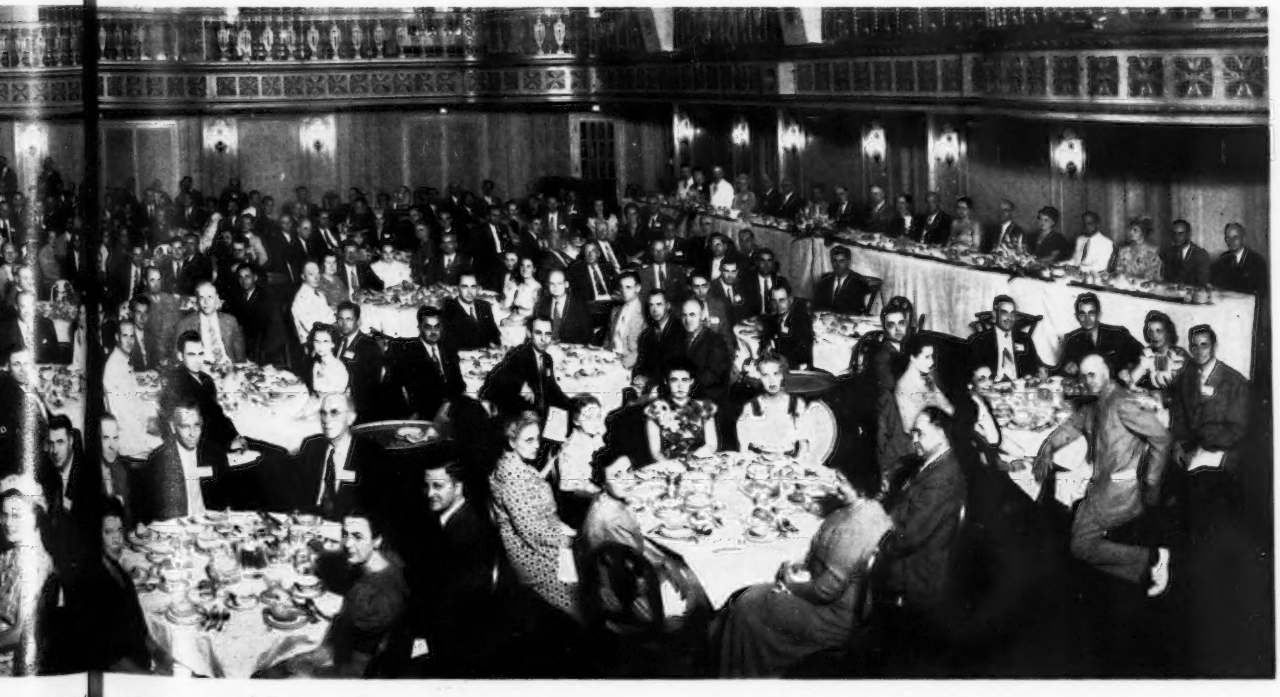
In 1925 we began alternating the choice of presidents between members in public service and private industry, and it is believed that members generally accept this as a desirable practice.

In selecting candidates for elective offices, the Nominating Committee, which is elected by the members, aims to approximate a three-fold balance on the Council — that is, (1) representation of the four main technical subdivisions of agricultural engineering, (2) regional representation, and (3) representation from private industry and public service. Considered over a period of years the balanced Council idea has been pretty well carried out.

Many of us put considerable importance on this matter of a balanced Council, and psychologically at least it is important. However, its practical importance has been largely offset by the so-called "Cabinet" setup established a few years ago.

Originally the Cabinet consisted of members of the Council, the chairmen of the Meetings Committee, and members of the division executive committees — that is, the chairmen, vice-chairmen, and junior past-chairmen of all divisions. Something over a year ago, however, the Council voted to include also the chairmen and secretaries of all the sections as members of the Cabinet. This Cabinet setup provides a simple, flexible, and democratic way for groups in the Society — or individual members, for that matter — to present questions or proposals for consideration. Such matters may be submitted at Cabinet sessions, which are held in conjunction with those of the Council at the Society's fall and annual meetings. The short experience we have had with the Cabinet has shown that it provides a convenient and appropriate forum for consideration by a representative group in the Society of the opinions, recommendations, etc., of any member or group of members.

* * *



pages are ... and members of their families gathered together for the Society's annual dinner at St. Louis, June 26

Student Branches. We have been pleasantly surprised at the number of our student branches that have been reactivated during the past year, following practical cessation of this activity during the latter part of the war period. There are now 13 active student branches, with a total membership of 223, at the following schools: University of Georgia, University of Idaho, Kansas State College, Louisiana State University, Michigan State College, Mississippi State College, University of Nebraska, North Dakota Agricultural College, Ohio State University, South Dakota State College, University of Tennessee, A. & M. College of Texas, and University of Wisconsin.

In addition, there are seven schools at which student branches have not been established, or reestablished, but at which a total of 94 graduate and undergraduate students are now enrolled in the grade of Student Member. These include Cornell University, University of Illinois, Iowa State College, Ohio State University, and Purdue University, and the University of Saskatchewan and Macdonald College in Canada.

In all probability the Farm Equipment Institute trophy, which the Society awards annually to one of its student branches having an outstanding record, and which has not been awarded for the past three years, will be reinstated in the 1946-47 school year.

* * *

As was expected, enrollment in agricultural-engineering curriculums at the land-grant colleges and universities is greatly exceeding that prior to the war. Our headquarters' office saw this coming even before the war ended, in letters received from both war veterans and boys about to graduate from high school. Where formerly letters inquiring about agricultural engineering as a professional career, and asking for information on schools offering professional agricultural-engineering curriculums, were rare, they are now of frequent occurrence. There are of course many things that contribute to this growing interest on the part of young men in agricultural engineering, but some share of the credit for it can rightfully be claimed on behalf of the "Career" booklet already mentioned in this report.

Why are we interested in increased enrollment at the land-grant schools? Simply because the bulk of these young men will become members of our student branches, and in due course members of the Society.

* * *

Teaching Seminar. At its meeting at Chicago last December, the Council gratefully accepted a grant of $15,000 from the Ferguson Foundation for a most worthy activity. The Foundation is a non-profit organization devoted to the advancement of agricultural techniques and practices, especially through aids to education, and the purpose of the grant was to make possible a seminar to be held this summer for college teachers of agricultural engineering, which would be devoted to the presentation and discussion of subject matter, course outlines, techniques of instruction, or any other material or practices designed to provide better preparation of students in this field. A special committee has been at work for several months on the conference program, which is now practically complete. The conference will be held at Purdue University late this summer. The grant will make possible payment of hotel expenses and all or part of the travel expense, depending on the number of those who qualify for the conference.

The Society is especially grateful for the generosity of the Ferguson Foundation in making this worthy project possible.

* * *

The Society Journal. In making this report each year, we take what we hope may be pardonable pride in reviewing the publishing activities in connection with our Society journal, AGRICULTURAL ENGINEERING. The "Journal" is important to us for several reasons, but mention will be made of the two that have most significance for us. In the first place, it takes money to run an organization like this, and during twenty of the twenty-five years we have published the Journal, it has contributed substantially to our income — usually more than half. During 1945, as our financial report shows, the net income from the Journal represented 72½ per cent of the total Society income for the year. Also, if we balance income (net) from the Journal (a total of $38,300, in round numbers) against expense of publishing it ($16,790), the Journal returned to the Society treasury last year $21,510 clear gain.

In the second place, we are proud of the Journal because of the job it does in recording and disseminating the accomplishments of our profession. The very finest contributions to agricultural engineering literature are to be found in its pages. Any agricultural engineering reference file or library is quite incomplete without the volumes of AGRICULTURAL ENGINEERING.

Another thing, in my judgment the Journal is the very best "press agent" our profession could have. Many of us have bewailed the fact that our Society activities do not get the publicity we believe is merited. Perhaps we would feel quite satisfied if we saw some of our accomplishments generously featured in the newspapers or over the radio. Of course we'll welcome all that kind of publicity we can get, but, after all, how lasting is its effect on most people? Aren't memories usually pretty short?

On the other hand, the type of publicity we get from circulation of the Journal is more permanent, if not so far-reaching. Sooner or later it gets attention in the places and among the people that really count most from our standpoint. During the past year requests for the Journal have increased much beyond anything we have experienced in the past, and these requests are not only for copies of current issues — and, of course, subscriptions — but also for copies of back issues, even to the very earliest published. In brief, the Journal contains the things that individuals and organizations want and can use, and while it is not of course the most spectacular way of bringing the Society and the accomplishments of agricultural engineers to the attention of those we most want to reach, doubtless in the long run it is the most effective.

* * *

President's Activities. As has occasionally happened in the past, the Society has been fortunate in having a president this year who has not only travelled extensively, but has also been able to combine Society activities with his regular work. President Long made three trips across the country during the year. On one of them he traveled 10,000 miles by automobile, over a period of three months. This particular trip was timed to permit his attendance at three section meetings and our fall meeting in Chicago. He attended, and addressed, all but one of the regional section meetings, as well as several meetings of local and state sections.

Your president visited several of the land-grant colleges on his trips, where, in addition to visiting agricultural engineering staffs, he talked with deans of agriculture and engineering. One of the outstanding contacts he made — with the chairman of the Committee on Engineering Schools of the Engineers' Council for Professional Development — gives promise of identifying our Society more closely with the E.C.P.D. program of accreditation of engineering curriculums.

Dewey Long has rendered the Society excellent service during his term as President, and I know all members will want to join in expressing to him — and also to the Douglas Fir Plywood Association — our sincere appreciation for his good work.

Finances. The status of Society finances and a record of receipts and expenses for the calendar year 1945 are given in a separate auditor's report, mimeograph copies of which have been mailed to each member.

If, in studying the financial report, our members were to compare the net gain, or profit, for last year ($18,500 in round numbers) with that of 1941 ($110), they would doubtless be inclined to ask why there has been so large an increase in the short space of five years. Several factors have contributed to this happy condition, but for the most part it is due to the fact that the Journal has benefited by the wartime boom in advertising.

Society income is derived mainly from two sources, namely, membership dues and Journal advertising. Other sources include Journal subscriptions and copy sales, admission fees, and sales of publications other than the Journal. Total of receipts for 1945 was $52,927.30.

The largest expense item for 1945 was that connected with the publication of the Journal, $16,794.70. The next largest was salaries, $10,800.00.

While the Journal expense item includes no salaries, it is interesting to note that the net gain from the Journal last year ($21,510) is practically double the salaries item.

Other expense items exceeding $500 in amount include General Printing and Supplies, $2,634; Postage, $1,177; Rent, Light, and Janitor, $849; Travel Expense, $1,005.

The total net gain for 1945 (receipts minus expenses) was $18,557.58. The nice gains which we have been able to show in the four-year period, 1942 to 1945, inclusive, has enabled us to set aside a reserve of $35,230 which is invested in United States Savings Bonds. Because our two main sources of income are particularly sensitive to low points in the economic cycle, a fact we have learned from two first-hand experiences, we believe it is wisdom to maintain a cash reserve sufficient to provide for at least one year's budget.

The auditor's report also shows that the Society has no indebtedness, a condition which has been maintained without interruption for close to 25 years.

Your staff at the headquarters' office — now five of us in all — wishes to express appreciation for the continued generous cooperation of officers and members in helping us carry on our work for the Society. It is a joy and a privilege to serve you.

Respectfully submitted,

(Signed) RAYMOND OLNEY, Secretary-Treasurer.

June 24, 1946

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NEWS SECTION

A.S.A.E. Meetings Calendar

September 10 to 12 — Lake Morey Inn, Fairlee, Vermont.

December 16 to 18 — FALL MEETING, Stevens Hotel, Chicago.

December 19 and 20 — 3rd Barn Hay-Curing Conference, Stevens Hotel, Chicago.

North Atlantic Section Meets in September

THE North Atlantic Section of the American Society of Agricultural Engineers will hold its annual meeting September 10, 11, and 12, at Lake Morey Inn, Fairlee, Vermont.

The arrangements for the program of the meeting will be under the general supervision of Section officers: F. M. Wigsten, chairman; M. S. Klinck, vice-chairman, and K. H. Gorham, secretary-treasurer. In addition, W. C. Harrington will be responsible for the farm structures portion of the program, F. W. Moffett, Jr., for power and machinery, H. N. Stapleton for rural electrification, and W. S. Atkinson for soil and water conservation. Ralph J. Bugbee is in charge of local arrangements.

Trullinger New OES Chief

DR. ROBERT W. TRULLINGER has been appointed to succeed Dr. J. T. Jardine as chief of the Office of Experiment stations, U. S. Department of Agriculture, effective August 1.

Dr. Trullinger is a native of Iowa and an enginering graduate of Iowa State College. In 1925 he was awarded the professional degree of agricultural engineering from that institution, and in 1941 the honorary degree of Doctor of Engineering by Rutgers University. Except for a period of about two years during World War I, while in military service, Dr. Trullinger has been continuously employed in the Office of Experiment Stations since March 1912. He became assistant chief of the Office in August 1938.

As OES assistant chief, Dr. Trullinger has assisted in the administration of federal grant funds for agricultural research in the states, territories, and Porto Rico, as authorized by the Hatch, Adams, Purnell and Bankhead-Jones Acts and supplementary acts, and assisted state agricultural experiment stations in matters of organization, policy, conduct of work, personnel, and relationships.

Dr. Trullinger is a Fellow of the American Society of Agricultural Engineers. He served the Society in the office of President in 1930-31, and in 1941 he was honored by the Society with the award of the John Deere Gold Medal.

S.A.E. Tractor Meeting, September 11 and 12

THE National Tractor Meeting of the Society of Automotive Engineers will be held at the Hotel Schroeder in Milwaukee, September 11 and 12.

The program for September 11 will include the following subjects and speakers: Power requirements of PTO-driven combines, by G. W. McCuen; power requirements of self-propelled implements, by John Borland; equipment for separately measuring power, by A. C. Ruge, J. H. Meier, and C. H. Gibbons; current influences of integral equipment, by K. W. Anderson; load reactions, weight transfer and operational effects, by D. C. Heitshu, and tractors for equal forward and reverse operation, by A. W. Turner.

The second day's program will feature subjects and speakers as follows: Tractor efficiency, by C. T. O'Harrow; traction as influenced by soils and their condition, by W. A. Gross, Jr., and A. D. Elliott; diesel engine requirements for farm tractor use, by L. A. Gilmer; economics of diesel power for farm tractors, by H. F. Bryan, and development of air-cooled engine design, by James Hoiby.

The dinner session on the evening of September 12 will be addressed by Fowler McCormick on the subject "New Horizons for Agriculture."

Directory Corrections

ERRORS in listings in the 1946 A.S.A.E. Membership Directory will be corrected when discovered and reported by Society members, and the correct listings will be given in this column. Changes in business connection, address, etc., subsequent to closing date for printing will not be included.

DeLong, H. H. (M)—Acting head, agricultural engineering dept., South Dakota State College, Brookings, S. D. (1939) G

McKibben, E. G. (F)—Agricultural engineer, Pineapple Research Institute of Hawaii, University of Hawaii, Honolulu, T. H. (Mail) 2500 Dole St. (1925) *(Continued on page 378)*

SCOOTERS
NEED AIR CLEANER PROTECTION TOO

Oil bath air cleaner protection is a vital safeguard to dependable performance and lengthened life of any internal combustion engine, regardless of its size or use.

For years the Cushman Motor Scooter has been equipped with United Oil Bath Air Cleaners. In the war this sturdy, economical, practical unit was employed by the Army and Navy as a carrier vehicle for all vital parts of supply around air strips. A special model was designed and used by U. S. Paratroopers. Today thousands of Cushman machines are performing many kinds of light delivery and transportation chores in cities, on farms, for business and pleasure.

United Oil Bath Air Cleaners, on engines from the smallest gasoline motors to large Diesel engines and industrial power units, play an important part in conserving operating life and durability. There's a United model for every size and type of high production engine.

This Cushman Motor Scooter is busy on the P-38 flight line at Lockheed Air Terminal.

United Oil Bath Air Cleaner, illustrated, is standard equipment on all present Cushman models.

UNITED SPECIALTIES COMPANY

UNITED AIR CLEANER DIVISION • CHICAGO 23 ★ MITCHELL DIVISION • PHILADELPHIA 36

AIR CLEANERS ★ WHEEL GOODS ★ METAL STAMPINGS ★ DOVETAILS
IGNITION AND DIRECTIONAL SIGNAL SWITCHES ★ ROLLED SHAPES

NEWS SECTION

(Continued from page 376)

1946 A.S.A.E. Paper Awards

ON THE occasion of the annual dinner of the American Society of Agricultural Engineers at St. Louis, Mo., on June 26, the retiring president of the Society, J. Dewey Long, announced the recipients of the 1946 A.S.A.E. Paper Awards previously selected by the Committee on Paper Awards consisting of M. H. Lloyd (chairman), I. D. Wood, F. W. Peikert, S. A. Witzel, E. L. Barger, and J. R. Carreker. These awards were based on papers published in AGRICULTURAL ENGINEERING during the calendar year 1945. Following are the recipients and papers under their authorship for which the awards were made.

Norval H. Curry, research associate, and Henry Giese, research professor of agricultural engineering, Iowa Agricultural Experiment Station. Citation: "Convertible Farm Buildings," AGRICULTURAL ENGINEERING, September, 1945. (Joint award).

R. H. Driftmier, head, agricultural engineering department, University of Georgia. Citation: "Postwar Opportunity in Agricultural Engineering," AGRICULTURAL ENGINEERING, July 1945.

W. D. Ellison, assistant chief, division of drainage and water control, Soil Conservation Service, U. S. Department of Agriculture. Citation: "Factors That Affect Surface Sealing and Infiltration of Exposed Soil Surfaces", AGRICULTURAL ENGINEERING, April, 1945 (C. S. Slater, joint author).

B. A. Jennings, professor of agricultural engineering, Cornell University. Citation: "Mow Curing of Hay", AGRICULTURAL ENGINEERING, March 1945.

James L. Strahan, technical director, Asphalt Roofing Industry Bureau. Citation: "A Method for Designing Insulation and Ventilation for Animal Shelter Buildings", AGRICULTURAL ENGINEERING, October, 1945.

Copeland Heads Mississippi A-E Department

J. T. COPELAND, for several years chief extension agricultural engineer at Mississippi State College, has been appointed the new head of the agricultural engineering department at that institution.

A.S.A.E. Teaching Seminar

OWING mainly to lack of housing and other facilities, attendance at the various sessions of the Agricultural Engineering Teaching Seminar, being sponsored by the American Society of Agricultural Engineers at Purdue University this summer, is being restricted to persons who are or will be engaged in parti-time resident teaching (not extension) of agricultural engineering subjects at the state agricultural colleges of the United States and of six Canadian provinces, and the Society is therefore issuing invitations only to persons of that category to attend the seminar. The expenses of those invited to attend will be paid from a fund established by a generous grant of the Ferguson Foundation of Detroit.

National Farm Electrification Conference

"TO bring together in conference individuals and groups interested in raising farm living standards and reducing farm production costs by increasing the profitable uses of electricity on farms," is the stated objective of the National Farm Electrification Conference to be held November 7 and 8, 1946, at the Hotel Sherman, Chicago. The Conference is being sponsored by several national organizations with particular interests in the development of farm electrification.

All who plan to attend are urged to make Chicago hotel reservations early.

Nominations for A.S.A.E. Medal Awards

IN ACCORD with the rules governing the award of the John Deere and Cyrus Hall McCormick gold medals, the Jury of Awards of the American Society of Agricultural Engineers will receive from members of the Society, up to November 1, nominations of candidates for the 1947 awards of these two medals.

Members of the Society nominating candidates for either award are requested to keep in mind the purposes of each medal and make their nominations accordingly. The John Deere medal is awarded for "distinguished achievement in the application of science and art to the soil," which citation is interpreted to cover more than a mechanistic concept of engineering, and to include chemistry, physics, biology, and any other science and art involving the soil, the "application" being acceptable to "evaluation by the engineering criteria of practicality and economic advantage."

(Continued on page 380)

A Concrete Haymow Floor minimizes fire damage

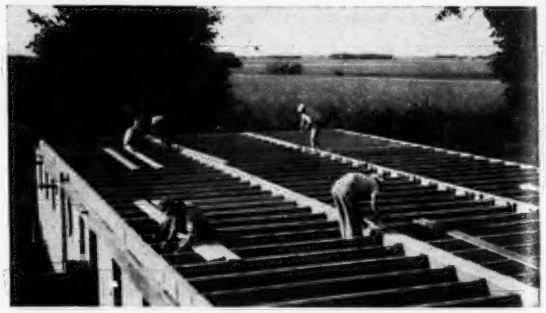
Concrete floors have demonstrated that they confine haymow fires to the structure above the floor and save livestock and equipment.

Statistics show 40,000 farm buildings destroyed by fire in 1944; $23,000,000 worth of farm barns burned. Spontaneous ignition and lightning are leading causes.

New design suggestions and latest data on how to build concrete haymow floors are available to assist agricultural and other engineers in providing this fire protection for farmers. Mailed free on request in United States and Canada.

PORTLAND CEMENT ASSOCIATION
Dept. S-1, 33 West Grand Ave., Chicago 10, Illinois

A national organization to improve and extend the uses of concrete . . . through scientific research and engineering field work



A properly designed concrete haymow floor like the one shown under construction above, would minimize damage if a fire occurred such as in the picture below.

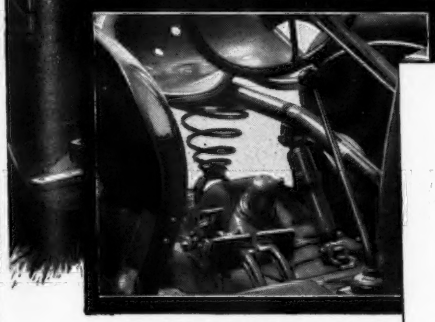
Another *First* for MASSEY-HARRIS

..the New "VELVET RIDE" Shock Absorber Seat!

Here at last is the kind of tractor seat that farmers have dreamed about . . . talked about . . . and tried to develop for years — a seat that does for the tractor what the shock absorber did for the automobile.

This new "Velvet Ride" shock absorber seat on Massey-Harris Tractors levels out the rough plowed ground . . . removes the bounces and bumps of cultivation . . . tames the broncho-busting, hell-for-leather ride of the conventional tractor seat.

It's another first for Massey-Harris . . . another reason why it pays to own a Massey-Harris.



Last year Michigan State College said: "The final riding quality of tractor seats could be greatly improved. This is a problem that deserves intensive study on its own account." — Quarterly Bulletin, August, 1945

WITH THE CONVENTIONAL TRACTOR SEAT THE TRACTOR JOLTS . . . THE OPERATOR JOLTS

WITH THE MASSEY-HARRIS "VELVET RIDE" SEAT THE TRACTOR JOLTS . . . THE OPERATOR DOESN'T

DRIVE a tractor with the conventional tractor seat over a rough field. Then take a Massey-Harris with the new "Velvet Ride" seat over the same ground. You'll experience for yourself what these graphs show — a rough, jolting ride tamed down to one of velvet smoothness.

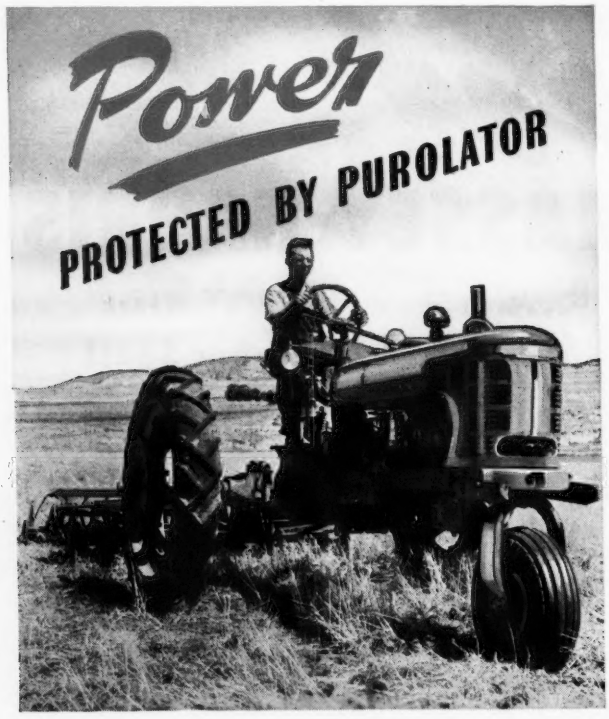
Hydraulic shock absorber, between the seat support and final drive case, cushions the jolts and bumps . . . lessens fatigue . . . saves arms and shoulder muscles . . . does away with the back pains of rough going . . . makes tractor driving safer for every member of the family. Variable tension coil spring instantly adjusts itself to any weight — the heaviest man or the merest slip of a girl.

It's advanced features like this that put so much extra selling value into Massey-Harris Tractors. Combine it with such other advantages as plus power on drawbar and belt . . . light fingered handling . . . penny-pinching economy . . . time-saving electric starting and battery ignition . . . roomy platform for a "seventh inning" stretch . . . the kind of vision that lets you see where you're going . . . a complete line of tools, and you'll see why more and more farmers are going Massey-Harris.

Massey-Harris Tractors are built in four power sizes for every size and type of farm . . . designed, engineered, tested, and field-proved to do a better job easier, at lower cost, for a longer time.

FOR LOW-COST FARMING BUY...

THE MASSEY-HARRIS CO.
General Offices: Racine, Wisconsin



THERE'S A GOOD REASON why leading makes of tractors are factory-equipped with Purolator Oil Filters. Purolators filter out the dirt, grit, grime and other damaging abrasives that get into a tractor's oil and score the pistons, cylinders, grind away bearings and shorten tractor life.

But a Purolator can only hold so much and no more of the abrasives it filters out of the oil. That's why it's important to change your Purolator element regularly.

Keep a supply of genuine Purolator elements on hand. Never run your tractor longer than the manufacturer recommends before changing to a new one. But be sure you always use genuine Purolator elements. Purolator makes and sells more tractor oil filters and tractor replacement elements than all other makes of oil filters combined. Purolator Products, Inc., Newark 2, N. J. In Canada: Purolator Products (Canada) Ltd., Windsor, Ont.

NEWS SECTION

(Continued from page 378)

The Cyrus Hall McCormick medal is awarded "for exceptional and meritorious achievements of a continuing career or to any single item of engineering achievement, and to apply equally to all special fields and types of engineering in agriculture."

The Jury of Awards desires that members of the Society consider it their duty and obligation to give serious thought to the matter and nominate for either or each of these awards the men they believe to be most worthy of the honor. Each nomination must be accompanied by a statement of the reasons for nominating a candidate and qualifications of the nominee, including his training, experience, contributions to the field for agriculture, a bibliography of his published writings, and any further information which might be useful to the Jury in its deliberations.

The Jury will accept and consider nominations received on or before November 1, and these nominations should be addressed directly to the Secretary of the Society at St. Joseph, Michigan. The Secretary will supply on request a standard set of instructions for preparing information in support of nominees for the Society's gold medal awards; in fact it is important that these instructions be followed in preparing material on behalf of any nominee.

Holman Heads Washington Section

AT THE June 14 meeting of the Washington (D. C.) Section of the American Society of Agricultural Engineers, concluding its 1945-46 meeting season, A. T. Holman, extension agricultural engineer, BPISAE, U. S. Department of Agriculture, was elected chairman of the Section for the ensuing year. Other officers elected were as follows:: Vice-chairman, N. R. Bear, chief, division of organization and personnel management, Office of Personnel, USDA, and secretary-treasurer, W. C. Hulburt, agricultural engineering divisions, USDA.

The meeting was held at the USDA Research Center at Beltsville, Maryland, and opened with a luncheon at the Log Lodge Cafeteria.

Following the luncheon, an address of welcome by Arthur W. Turner, assistant chief, Bureau of Plant Industry, Soils, and Agricultural Engineering, in charge of the agricultural engineering divisions, opening the formal program, following which motion pictures were shown of activities in the field of agricultural engineering research.

One hour of the program was devoted to a symposium by representatives of the four USDA divisions of agricultural engineering, including T. E. Hienton, head of the new division of farm electrification; J. R. McCalmont and J. R. Dodge for the division of farm buildings and rural housing; Geo. R. Boyd, head of the division of mechanical processing of farm products, and R. B. Gray, head of the farm power and machinery division.

Following the symposium inspection trips were made to see the cold storage investigations being conducted by the Bureau of Human Nutrition and Home Economics and of the mow hay drier equipment in the dairy building at the research center.

Personals of A.S.A.E. Members

Ralph H. Allee of the Office of Foreign Agricultural Relations, U. S. Department of Agriculture, has resigned to become director of the Inter-American Institute of Agricultural Sciences at Turrialba, Costa Rica.

Leonard W. Bonhorst has been released from the U. S. Naval Reserves with which he served during the war, and is now engaged as engineer on canal location work with the Bureau Reclamation, U. S. Department of the Interior at Bismarck, N. D.

Harry E. Besley, who has been on active duty with the U. S. Army Engineer Corps, was recently promoted from lieutenant colonel, AUS, to colonel, Engr-Reserve, and placed on terminal leave. He has returned to the New Jersey State College of Agriculture, to become head of the agricultural engineering department.

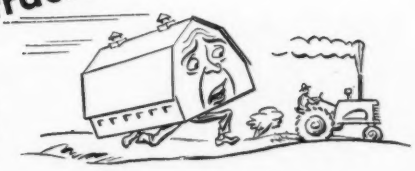
Albert L. Burkett, who more recently has been engaged as agricultural engineer at the Estacion Experimental Agricola de Tingo, Tingo Maria, Peru, has been transferred to Havana, Cuba, where he will be engaged in fiber machinery research on a cooperative project carried on by the U. S. Department of Agriculture and the Ministry of Agriculture of Cuba.

William N. Craig, who served as a radio officer in the Army during the war with the rank of Captain, is back to civilian life and is now engaged as agricultural engineer for the Mississippi Power and Light Company at McComb, Miss.

Richard F. Dudley, who during the war served as a lieutenant in the Army Air Force Transport Service is a civilian again and is employed as assistant agricultural engineer in the department of agricultural engineering at the Mississippi Agricultural Experiment Station.

(Continued on page 382)

Has his barn caught up with his tractor ?



The old-fashioned, inefficient barn is a time-waster. It forces a farmer to do his chores "the hard way"—not the easy Jamesway. Yet it's easy to make a barn as modern as a tractor. Here's how . . .

Your barn is warmer in winter, cooler in summer with Jamesway VENTILATION.
Make your barn brighter, healthier, comfortable with Jamesway WINDOWS.
Just a push saves a lot of steps with a Jamesway LITTER CARRIER.
Save time, save steps, save work with Jamesway LEVER STALLS.
Boost milk, butterfat output 5 to 10% with Jamesway WATER CUPS.
Make one step do the work of 16 with a Jamesway FEED CART.

See how Jamesway Barn Equipment saves time and multiplies farming profits

A farmer is missing something if he steps from 1946 to 1910 the moment he walks into his barn! With modern, efficient Jamesway "Chore Savers" he can do in his barn what modern machinery has done in the field . . . cut work hours in half, end drudgery, increase production and profits.

The complete Jamesway line of "Chore Savers" is illustrated and described in the new Jamesway Farm Building Book. You'll want a copy before you make any suggestions for building or remodeling and equipping any barn, poultry house, hog house, or other farm building.

It's easy to modernize the Jamesway. It can be done gradually at surprisingly little cost. Your local Jamesway dealer will be glad to cooperate with you in helping farmers work out their plans. Get acquainted with him. For the farm building book, write to department A-846.

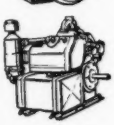
Jamesway

Fort Atkinson, Wisconsin

Elmira, N. Y. Oakland, Calif.

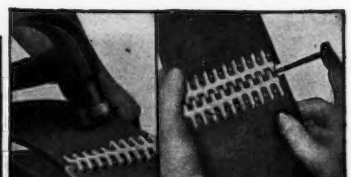
The FARM POWER LOAD
is Shifting More and More to
WISCONSIN HEAVY-DUTY
Air-Cooled ENGINES

Constant improvement in farm machinery and the development of new, ingenious equipment to lighten the farmers work-burden and increase the productive capacity of both men and machines, calls for an increasing use of self-contained power . . . in power packages not available through the tractor or rural electrification.
Wisconsin Heavy-Duty Air-Cooled Engines are participating in this modern phase of farm progress to a very considerable extent . . . because these engines have all the requisites for dependable, efficient farm service. Heavy-duty design and construction throughout, weather-proof air-cooling, light weight, extreme compactness, and a power range of 2 to 30 hp. (single cyl. and 4-cyl. types), adapts Wisconsin Engines ideally to a great variety of farm machines and farm jobs.



Most H.P. per pound
WISCONSIN MOTOR
Corporation
MILWAUKEE 14, WISCONSIN, U. S. A.
World's Largest Builders of Heavy-Duty Air-Cooled Engines

BELT LACING and FASTENERS for transmission and conveyor belts



"JUST A HAMMER TO APPLY IT"

ALLIGATOR
Trade Mark Reg. U. S. Pat. Office
STEEL BELT LACING

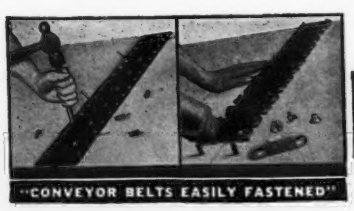
World famed in general service for strength and long life. A flexible steel-hinged joint, smooth on both sides. 12 sizes. Made in steel, "Monel Metal" and non-magnetic alloys. Long lengths supplied if needed. Bulletin A-60 gives complete details.

FLEXCO HD
BELT FASTENERS AND RIP PLATES

For conveyor and elevator belts of all thicknesses, makes a tight butt joint of great strength and durability. Compresses belt ends between toothed cupped plates. Templates and FLEXCO Clips speed application. 6 sizes. Made in steel, "Monel Metal", non-magnetic and abrasion resisting alloys.

By using Flexco HD Rip Plates, damaged conveyor belting can be returned to satisfactory service. The extra length gives a long grip on edges of rip or patch. Flexco Tools and Rip Plate Tool are used. For complete information ask for Bulletin F-100.

Sold by supply houses everywhere



"CONVEYOR BELTS EASILY FASTENED"

FLEXIBLE STEEL LACING CO.
4677 Lexington St.
Chicago, Ill.

Personals of A.S.A.E. Members

(Continued from page 380)

George B. Duke has resigned as sales engineer of the John Deere Plow Company at Valdosta, Ga., to accept appointment as instructor in agricultural engineering at the Abraham Baldwin Agricultural College at Tifton, Georgia, affiliated with the University of Georgia System.

J. Ivan Fredregill, who was a major of ordnance in the Army during the war, is a civilian again and is engaged as soil conservationist with the U. S. Soil Conservation Service at Adel, Iowa.

Rene Guillou has resigned as research engineer in the college of engineering at the University of California in Los Angeles to accept appointment as professor of agricultural engineering, University of Hawaii, and agricultural engineer, Hawaii Agricultural Experiment Station, Honolulu 10, Hawaii.

Wesley A. Harper, formerly farm sales manager, Lubrite Division, Socony-Vacuum Oil Co., is now agricultural engineer, Rome Plow Co., Cedartown, Ga.

Ralph C. Hay, associate professor of agricultural engineering extension, is now on leave half time from the University of Illinois to act as executive secretary of the Illinois State Soil Conservation Districts Board. This arrangement was made in order that Mr. Hay might keep in closer touch with the 71 soil conservation districts in Illinois in matters pertaining to equipment, drainage, flood control, and other engineering work. The remaining half of his time will still be devoted to agricultural engineering extension work in the state.

Samuel G. Huber, who served as an ensign in the U. S. Naval Reserves during the war, is now extension agricultural engineer specializing in farm machinery at Ohio State University, Columbus.

Lester G. Kopp has recently joined Harry Ferguson, Inc., as development engineer and will be engaged in research and development work on farm implements. He was previously employed as service engineer in the wheel and brake division of the Goodyear Aircraft Corporation.

Leonard J. Larson, who has been a farm implement dealer at Hecktor, Minn., recently joined the U. S. Soil Conservation Service in the capacity of soil conservationist and engineer and will be engaged in flood control operations on the Little Sioux River with headquarters at Sioux City, Iowa.

Vincent McKeever is now connected with the U. S. Soil Conservation Service at Philippi, West Virginia, in the capacity of soil conservationist and is engaged in engineering work.

John W. Propst, Jr., a captain in the Engineer Corps of the Army during the war, is now out of service and has joined the staff of the agricultural engineering department of the Virginia Polytechnic Institute at Blacksburg as assistant extension agricultural engineer.

J. W. Simons, agricultural engineer, Division of Farm Buildings and Rural Housing, BPISAE, U. S. Department of Agriculture, was recently transferred to Athens, Georgia, to take charge of a project on crop storage which is cooperative between the Division and the agricultural engineering department at the University of Georgia. Mr. Simons was in charge of a cooperative farm housing project at Athens prior to the war. His new work will deal with problems of storing grain, sweet potatoes and other crops in Georgia and the southeastern states.

Samuel J. Strebin has accepted a position with the Ministry of Agriculture in Venezuela where he will be employed the next two years in work primarily concerned with making soil surveys.

(Continued on page 383)

PROFESSIONAL DIRECTORY

GEORGE R. SHIER, A. E.
Consulting Engineering Work In Farm Structures Field
Also Sales Engineering for Selected Manufacturers
Member A. S. A. E. Associated with Howard S. Sterner Company, Consulting Structural Engineers, 8 East Broad Street, Columbus, Ohio

FRANK J. ZINK ASSOCIATES
Agricultural Engineers
Consultants on product development, designs, research, market research, public relations
FELLOW A.S.A.E. Suite 4300, Board of Trade Bldg.
MEMBER S.A.E. Telephone: Harrison 0723 Chicago 4, Illinois

RATES: Announcements under the heading "Professional Directory" in AGRICULTURAL ENGINEERING will be inserted at the flat rate of $1.00 per line per issue; 50 cents per line to A.S.A.E. members. Minimum charge, four line basis. Uniform style setup. Copy must be received by first of month of publication.

Personals of A.S.A.E. Members

(Continued from page 382)

John G. Taylor, who saw service with a radar maintenance unit of the Army during the war, recently accepted employment as agricultural engineer with the Rural Electrification Administration, USDA, in Washington.

O. J. Trenary recently resigned his position with the farm industry division, General Electric Co., to accept appointment as extension agricultural engineer at Colorado State College, Fort Collins.

Geo. C. Vaughan, who was a major in the Army Air Force during the war, recently accepted a position as senior research engineer with the John Deere Tractor Company at Waterloo, Iowa.

Vernon H. Van Diver, has resigned as manager of the advertising division, general publicity department, Union Carbide and Carbon Corporation, to open his own business as merchandising and advertising counselor with offices in the McGraw-Hill Building. New York. Mr. Van Diver will also head the Brad-Vern Company, an advertising agency at Garden City, New York.

Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Landy B. Altman, Jr., field agricultural engineer, Rural Electrification Administration. (Mail) 601 Grand Building, Macon, Ga.

Donald W. Bates, district agricultural engineer, agricultural engineering department, Cornell University. (Mail) c/o C. L. Freer, Sharon Springs, N. Y.

Walter L. Churchman, general manager (agriculture), Andelot, Inc., Worton, Maryland.

Otis E. Cross, engineer, Boeing Aircraft Company. (Mail) Burrton, Kansas.

V. R. Despard, Jr., manager, flame cultivation division, New Holland Machine Co., New Holland, Pa.

Severyn E. Dettlaff, mechanical engineer, Cleaver-Brooks Company, Milwaukee, Wis. (Mail) 2242 South Seventh Street.

Arnold M. Flikke, instructor in agricultural engineering, University of Minnesota, St. Paul 1, Minn.

Gordon L. Glassford, director of engineering, Chek-Chart Corp., 624 S. Michigan Ave., Chicago, Ill.

James Russell Hallock, rural service department, Central Hudson Gas & Electric Corporation. (Mail) Box 222, Milton, N. Y.

Daniel E. Havelka, hydrology engineer, Hydrology Division, Bureau of Reclamation, USDI. (Mail) 730 Washington St., Denver, Colo.

Harrold B. Jones, extension cotton ginning specialist, Extension Service, University of Tennessee, 1515 W. Cumberland, Knoxville, Tenn.

Robert W. Kash, Jr., assistant county agent, Virginia Agricultural Extension Service, Halifax, Va.

John B. Liljedahl, 312 Hayward Ave., Ames, Iowa.

B. F. Muirheid, extension specialist in agricultural engineering, University of Illinois, Urbana, Ill.

John W. Parrish, agricultural engineer, Soil Conservation Service, USDA. (Mail) Batavia, Ohio.

Ray M. Ritchie, Jr., assistant county agent, Nansemond County, Box 144, Suffolk, Va.

Paul G. Strom, manager, agricultural extension division, American Steel & Wire Co., Rockefeller Bldg., Cleveland 13, Ohio.

Louis B. Strong, rural electrification specialist, Extension Division, Oklahoma A. & M. College, Stillwater, Okla.

Cecil W. Wheary, post-graduate student, agricultural engineering dept., Virginia Polytechnic Institute, Blacksburg, Va. (Mail) General Delivery.

Clopton F. Wilkinson, jr., assistant agricultural engineer, agricultural extension division, Virginia Polytechnic Institute, Blacksburg, Va. (Mail) Box 222.

TRANSFER OF GRADE

James E. Beamish, assistant director of agricultural development and extension, Department of Agriculture, Province of British Columbia, Parliament Bldgs., Victoria, B. C., Canada. (From Junior Member to Member)

A. W. Cooper, associate agricultural engineer, Alabama Polytechnic Institute, Auburn, Ala. (From Junior Member to Member)

Round and Round They Go,
All Over the World!
EWC WHEELS
We've been making good wheels for more than half a century—and had begun to get a little complacent about it—until people began telling us what a job EWC Wheels were doing all over the world. Our accumulated experience, and modern engineering combine to produce outstandingly fine wheels to meet every need. Now, with the most modern equipment to produce disc wheels, we are in a doubly fine position to work with you.
Write for special information about EWC Wheels.
EWC WHEELS
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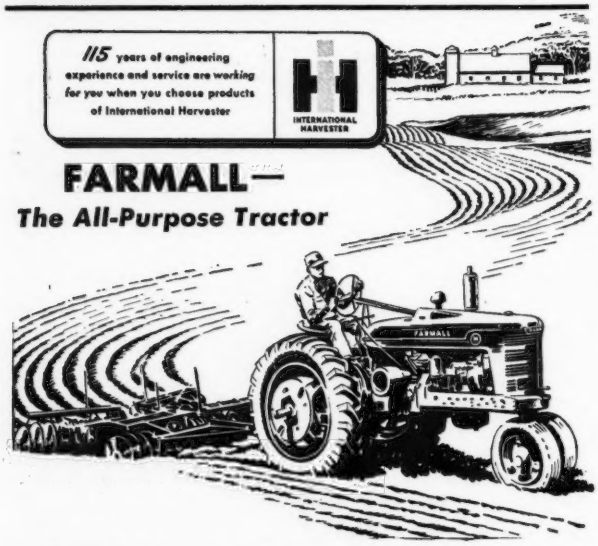

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Personnel Service Bulletin

The American Society of Agricultural Engineers conducts a Personnel Service at its headquarters office in St. Joseph, Michigan, as a clearing house (not a placement bureau) for putting agricultural engineers seeking employment or change of employment in touch with possible employers of their services, and vice versa. The service is rendered without charge, and information on how to use it will be furnished by the Society. This bulletin contains the active listing of "Positions Open" and "Positions Wanted" on file at the Society's office, and information on each in the form of separate mimeographed sheets, may be had on request.

NOTE: In this Bulletin the following listings still current and previously reported are not repeated in detail. For further information see the issue of AGRICULTURAL ENGINEERING indicated:

POSITIONS OPEN: FEBRUARY—O-448, 452. MAY—O-495, 497, 498, 499, 500, 501, 502, 503. JUNE—O-504, 505, 506, 507. JULY—O-508, 509.

POSITIONS WANTED: FEBRUARY—W-207, 210, 211, 234, 248, 254, 267, 270, 291, 296. APRIL—W-232, 237, 240, 258, 262, 265, 273, 276, 281, 283, 285, 290, 292. MAY—W-302, 305, 306, 307, 309, 311, 312, 313. JUNE—W-315, 316, 317, 319, 320, 321, 322. JULY—W-323, 324, 325, 326, 327, 328, 329.

Attention is invited to the desirability of checking on the housing situation when considering a new location.

POSITIONS OPEN

AGRICULTURAL ENGINEER wanted by the Allahabad Agricultural Institute, Allahabad, India, for teaching position. Minimum qualifications, degree in agricultural engineering and some farm experience. Postgraduate degree desirable. Duties would be primarily teaching, with some opportunity to participate in research and extension. Candidate must be active Christian interested in mission work. Discharged veteran with slight handicap eligible if in good health otherwise. Applicants may correspond with the New York office of the Allahabad Agricultural Institute, attention of Dr. Herrick B. Young, 156 Fifth Ave., New York 10, N. Y.

AGRICULTURAL ENGINEER (assistant or associate professor rank) wanted by southeastern land grant university for full time research on farm machinery and equipment. Prefer man with an advanced degree or equivalent industrial research experience; and ability to meet people to put over research development. Age, under 40. Salary $3000 - $4000, depending on experience. O-510

AGRICULTURAL ENGINEER wanted by southeastern farm equipment manufacturer expanding line, to make layouts and detailed drawings of parts for new machine design, mostly in the field of heavy-duty tillage implements. Must like to create design and make detailed drawings. Should have BS deg in agricultural engineering or equivalent, farm background, and some experience since graduation. Opportunity to advance to department head. Age 25-50. Salary $2400 - $3000. O-511

AGRICULTURAL ENGINEER wanted by large distributor for development of irrigation systems, including drafting and working closely with buyers and manufacturing sources. BS deg in agricultural engineering and ability to get along with people desired. No particular experience is required as man selected will be trained for the work. Opportunity for advancement in engineering department or buying organization. Location, Midwest. Age 24-28. Salary $2600 - $3250. O-512

AGRICULTURAL ENGINEER wanted by western land grant college to head and build up agricultural engineering department. Work will involve teaching in farm equipment, structures, and electrification, plus research, extension and administration. Man particularly well qualified in farm machinery is desired. Advanced degree preferred. Age—under 35. Salary $3600 max. O-513

AGRICULTURAL ENGINEER wanted by northeastern land grant college as assistant to present extension agricultural engineer, to expand program in farm machinery and structures. Prefer young man with farm background, BS deg in agricultural engineering, some familiarity with extension methods, and other usual qualifications for extension work. Salary increases as development warrants. Salary $2400 - $2700. O-514

POSITIONS WANTED

AGRICULTURAL ENGINEER desires sales, service, development, or extension work in farm machinery field. BSAE deg, North Dakota Agricultural College, 1943. Professional certificate in meteorology, UCLA, 1943. Farm background. Two summers work as AAA farm supervisor. One year as weather forecaster in AAF. Recently released from active duty in the Army. No physical defects. Available Aug. 15 to Sept. 1. Married. Age 26. Salary $2500 - $3000. W-330

AGRICULTURAL ENGINEER desires development, research or extension work in farm structures and utilities. BSAE deg, South Dakota State College, 1942. Farm background, four summers work on federal experiment farm. Assisted in research part time while in college. Nearly 4 years commissioned service in Corps of Engineers. Six months as agricultural engineering extension specialist since release from Army. No physical defects. Available Sept. 1. Married. Age 25. Salary $3200 - $3600. W-331

AGRICULTURAL ENGINEER desires sales or service work in private company, with opportunity to develop and qualify for increasing responsibilities. BSAE deg, Oklahoma A. & M. College, 1939. One year as project engineer in water facilities bureau of U. S. Soil Conservation Service. Commissioned service in Corps of Engineers for 5½ years, with variety of experience in supervision and construction. No physical defects. Available January 10, 1947. Married. Age 29. Salary open. W-332

AGRICULTURAL ENGINEER desires development, research, or teaching work in power and machinery or soil and water conservation field. BSAE Pennsylvania State College, 1939. Four semesters teaching agricultural mechanics; mechanic on large cranberry and blue berry farm 1½ years; agricultural engineer in soil conservation department of large eastern corporation farm (present employer) one year. Available one month after acceptance. Married. Age 29. Salary open. W-333